Solution for Efficient Lighting Control System

Thesis submitted in partial fulfillment of the requirements for the award of degree of

Master of Engineering

in

Computer Science and Engineering

Submitted By

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CERTIFICATE

I hereby certify that the work which is being presented in the thesis entitled, "***Solution for Efficient Lighting Control System***", in partial fulfilment of the requirements for the award of degree of Master of Engineering in *Computer Science and Engineering* submitted in Computer Science and Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of ***Dr. A. K. Verma and Pranab Bhandari*** and refers other researcher's work which are duly listed in the reference section.

The matter presented in the thesis has not been submitted for award of any other degree of this or any other University.

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This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.

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Abstract

Energy Saved is Energy Generated : When we save one unit of energy, it is equivalent to 3 units of energy produced.

A typical 50,000 sq. ft. commercial building spends about $45,000 each year on lighting energy. Much of that money is wasted due to ineffective light control. Through optimizing electric light and daylight, Quantum can cut those costs by 60% or more while greatly improving the visual environment. Climate change and growing shortages of resources are the big challenges of our time. In addition, many countries around the world are dependent on imported energy – in the EU, for example, 50 % of energy consumed today is imported – a figure expected to reach 70 % by 2030. Efficient and sustainable energy usage is therefore an urgent necessity – fully in accordance with the motto coined by the European Commission “less is more”. Heating, cooling and lighting in residential and office buildings make up approximately 40 % of the energy consumed.

The main focus of the work presented is to utilize the energy consumption of building (Home or office), taking into account various parameters such as – Fixtures, time of the day, geographical location of the building, type of load etc. The major contribution is that we can also measure the energy saved in the said duration. This work also assumes importance in today’s global scenario because energy conservation is the only course of action that can be taken to meet the energy demand (which is also overly priced), further the proposed solution improves energy efficiency of the building by ensuring the comfort conditions of the building.

Keywords: Lighting, Fixture, Hyperion Algorithm, Dimmer, Sensor.

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CHAPTER 1
INTRODUCTION

The luxurious cars in which we roam around and the shivering cold atmosphere created by the air conditioners in hot seasons and also the lights which brighten up our homes at night makes our lives so relaxing and pleasant.

No one can dare to even dream of life without them. But have you ever imagined the amount of energy required to run these machines! Have you ever estimated the amount of carbon effluents emitted by them into the atmosphere! Aah! Fortunately, people all over the country are becoming aware of the problem of consuming too much energy and are making a conscious effort to conserve it.

Quantum prevents wasted lighting energy by maximizing the efficient use of light in your building. Quantum automatically dims or switches all electric lighting and controls daylight using automated window shades. Quantum manages, monitors, and reports on all the lighting usage in your building for optimal energy performance and productivity while minimizing maintenance and operating costs.

Energy conservation is basically the practice of reducing the amount of energy used to accomplish the same. India accounts for about 17% of world's population but has just 1% of world's energy resources.

Switching to renewable sources of energy is another way to save non-renewable sources of energy. We can use solar heaters and biogas plants for domestic and industrial purposes.

1.1 What is Light Control?

Quality lighting is an important aspect of our daily life, and is often taken for granted. Light control is the ability to regulate the level and quality of light in a given space for specific tasks or situations. Controlling light properly not only enhances the experience; it helps to save energy by using light when and where it is needed most.

1.2 The Benefits of Dimming

In the average home, most light controls are a simple on/off switch, rather than a dimmer. This means that whether it's the middle of the day or it's nighttime, your fixtures are putting out the exact same amount of light. In fact, light switches are one of the few appliances that only have two settings – on and off. Through dimming, users can control the quantity of light their fixtures provide to fit specific tasks, moods, or situations. This not only improves the experience, but also saves wasted energy in the process.

1. 3 Daylight Harvesting

In addition to managing electric light, regulating the amount of daylight that enters a space is an important aspect of light control. By using shades in conjunction with dimmers, Lutron systems can create the perfect balance between the two sources of light to save energy and create an inviting environment. Dimming modifies the quantity of electric lights, which in turn are complimented by the proper shade fabric and control that filters daylight. Together they save energy while providing the right amount of light for specific tasks or situations.

1.4 Total Light Control

True light control reaches further than shading and dimmers. Lutron light management systems and equipment can make lighting a vibrant and vital part of any space. Daylight sensors, for example, can automatically adjust shades and overhead lights to maintain the perfect look throughout the day, while occupancy sensors can ensure that lights are never left on when a room is not in use.

1.5 What are the benefits of Lighting Control System?

1.5.1 Save electricity and protect the environment

Reduces greenhouse gases by eliminating unnecessary energy use[ ]. More electricity is used for lighting than any other building system. Controlling your lighting is usually the easiest and most visible way to manage your energy costs while enhancing your space. Light control strategies such as tuning, dimming, occupancy sensing, daylight harvesting, scheduling, and automatic shading reduce energy consumption which conserves natural resources and lowers the amount of CO_2 released into the air.

Fig. 1.1 Distribution of electricity in the office building [1]

1.5.2 Save money

- Lowers operating costs and peak demand charges.
- Lower operating and maintenance costs.
- Automatically turn off lights in vacant spaces
- Use only the amount of electric light needed
- Minimize electricity demand charges by lowering light levels during peak periods
- Reduce lighting and HVAC loads by dimming lights and automatically controlling shades
- Report lamp failures for optimal group re-lamping

1.5.3 Create a more flexible space

Create a more flexible space Lighting and shading zones can be re-configured without rewiring. Easily control and re-configure light sources. Lighting and shading zones can be re-configured without rewiring, making a space adaptable to high churn rates. As the needs of a space change, wall controls, occupancy sensors, and daylight sensors can be reassigned to different fixtures or groups of fixtures.

1.5.4 Increase productivity and comfort

Makes occupants more productive and comfortable with preferred light levels and automated shade control Make your tenants or House owner/Office Worker more productive with selectable preferred light levels for specific tasks. Since 90% of information is received visually, having the right light for the job is crucial. Research indicates that people are more productive working in their preferred light level. Shade control eliminates harsh sun glare and heat making employees more productive and comfortable And increasing comfort and productivity improves House owner recruitment and retention.

1.6 Targeted Audience

- Office
- Education
- Healthcare
- Hospitality and other buildings
- For new construction or renovations

1.7 Key components of light management [1]

1.7.1 EcoSystem Fluorescent Dimming Ballast

Sets light level to your task(100% to 10% dimming)

Fig 1.2 Fluorescent Dimmer

1.7.2 Occupancy Sensor

saves energy and increases convenience by automatically turning lights off when space is vacant, and on when space is occupied.

Fig 1.3 Occupancy Sensor

1.7.3 Daylight Sensor

Saves energy by reducing electric lighting usage based amount of daylight.

Fig 1.4 Daylight Sensor

1.7.8 Personal Control (hand-held remote)

controls your lights from anywhere in your space for comfort and convenience.

Fig 1.5 Hand-held remote

1.7.9 Shades

Reduce sun glare and solar heat gain for increased productivity, comfort, and energy savings while preserving views.

Fig 1.6 Shades

1.7.10 Electronic Drive Unit

These units quietly controls shades with ultra-precise alignment, as shown in the figure below.

Fig 1.7 Electronic Drive Unit

1.7.11 GRAFIK Eye QS

Controls multiple shade and light zones and creates light scenes at the touch of a button

Fig 1.8 GRAFIK Eye

1.7.12 Keypad Wall stations

Select a preferred light level for every task, and adjust shades quietly at the touch of a button

Fig 1.9 Keypad Wall stations

1.7.13 Green Glance™ Software

Shows building occupants the environmental and energy savings that result from Quantum

Fig 1.10 Green Glance

1.8 Energy savings and light control strategies [1]

Architectural load dimming

Allows the users to dim traditional light sources such as incandescent, halogen, low voltage, and LED.

Fluorescent dimming
Highly efficient dimming that allows the users to dim fluorescent light down to 1% of full light output.

Controllable window shades
Allows quiet control of daylight for improved comfort and productivity using Sivoia® QS shades.

Switching
Allows the user to switch on or off all non-dimmed light sources using 1 million cycle relays.

High-end trim
High-end trim sets the maximum light level for each space, providing guaranteed energy savings.

Light level tuning
Sets the target light level based on customer requirements in each space. This level is lower than the high-end trim light level.

Scene and zone control
Users can select pre-programmed light scenes or raise and lower individual light zones.

Scene control
Users can select pre-programmed light scenes at the touch of a button.

Personal light control
Allows users in the space to select the correct light level for the desired task. Often that is much less light than full-on.

Occupancy or vacancy sensing
Automatically turn off lights when people vacate the space.

Daylight harvesting
Automatically adjusts the electric lighting levels based on the amount of daylight in the space.

Scheduling
Lights turn off or are dimmed and shades are adjusted automatically at certain times of the day or in relation to sunrise and sunset.

Hyperion™ solar-adaptive shading
Automatically adjusts Lutron Sivoia® QS window shades based on the angle of the sun to maximize the effective use of daylight.

Partitioning
Automatically adapts the lighting controls to changes in room configurations.

IntelliDemand™ load shed (demand response)
Allows the facility manager to reduce lighting load at times of peak electricity pricing.

Remote monitoring and control
Allows management of your building's light from anywhere in the world.

Reporting and trending
Allows the system operator to intelligently manage and monitor the lighting in their building.

CHAPTER 2
LITERATURE REVIEW

The movement of energy conservation started in the late 1970s and early 1980s mainly due to the 1973 oil embargo [5]. In view of tightening energy supplies and sharply rising cost, new approaches to controlling energy consumption were put into effect. Initially, conservation was largely based on operations and maintenance approaches [8]. These are still the most cost effective. It is import to periodically review buildings to be sure they are being operated and maintained in an energy efficient manner. Energy conservation is an important part of the commissioning process. Energy conservation today involves much more in the way of capital improvements then it did a few years ago. There are many proven products and services available to reduce utility costs [10]. Early Energy Conservation efforts were sometimes seen as a nuisance to building occupants. Today many of the improvements being made primarily to conserve energy actually improve the attractiveness, comfort, and usefulness of the building [6]. At today’s energy prices, the strongest argument for conservation and an energy management program is the cost of not conserving

Practical experience has shown that the reduction of the room temperature by 1 °C can reduce the consumption of heating energy by 6% [11]. If the room temperature is reduced by 3 °C during absence, 18 % of the heating energy can be saved in a non-occupied room. As the temperature level typically reacts slowly, this form of control is only useful for prolonged absences.

The very idea was radical. At that time, lighting control was a complicated and expensive affair, requiring bulky rheostats that used a lot of energy and generated a great deal of heat. Consequently, lighting controls were used primarily to dim stage lights in theaters. Most people would never think of having dimmers in their homes because they were just too difficult to install[12]. That all changed in 1959, when Spira emerged from his lab with a solid-state dimmer that could replace the light switch in a standard residential wall box. Spira’s key technical innovation had been to replace the rheostat with a thyristor. A thyristor is a type of transistor, which had been invented a few years earlier [12].

The substitution was effective because rheostats and thyristors worked in completely different ways. Rheostats dimmed lights by absorbing electrical energy into the rheostat, meaning that electricity was converted to heat in the rheostat rather than to light in the lamp. By comparison, thyristors dimmed the light by interrupting the power flowing to the lamp. The use of a thyristor shrank the size of a dimmer until it could fit into a standard wall box. Spira's dimmer also generated much less heat than a rheostat and used much less energy. An old Indian saying indicates "The earth, water and the air are not a gift to us from our parents but a loan from our children."

2.1 The Science of Lighting

Lighting design has two major components: [14]

(1) quantity, or the amount of light, specified in terms of luminance and intensity; and

(2) quality, referred to in terms of the color-rendering properties of a lighting system;

The absence or presence of veiling reflections, the effectiveness of a luminaries lighting its intended target, and the amount of glare caused by a lighting system within its sphere of influence.

While quantity (e.g., intensity and luminance) is rather simple to measure photo metrically, trying to ascertain the quality of a lighting system is much more difficult to evaluate. Yet, the quality of a lighting system is an important factor in evaluating the effectiveness of a design, as it will directly affect the requirements for quantity. Proper lighting design requires that attention be paid to both quantity and quality [16]; one without the other often yields a visual environment that is both uncomfortable for its inhabitants and inefficient in its energy utilization.

2.2 Measurement of Light Levels

The visual portion of the electromagnetic spectrum is generally considered to include the wavelengths between 380 and 760 nm (nanometers), ranging from violet at the short end to red at the long. This is called the visible spectrum. Any energy within this narrow range will stimulate the human eye's sense of vision. Different wavelengths of energy are perceived as different colors, as summarized in Table

Table 2.1 Wavelength and color distribution [23]

Color	Wavelength (nm)
Red	760 - 630
Orange	630 - 590
Yellow	590 - 560
Green	560 - 490
Blue	490 - 440
Indigo	440 - 420
Violet	420 - 380

To understand the relationship between lighting units, Pitts and Kleinstein3 recommends starting with a point source; that is, an infinitesimally small source of light that has no area and radiates light equally in all directions. This radiation pattern creates a perfect sphere, as shown in Figure 2.1.

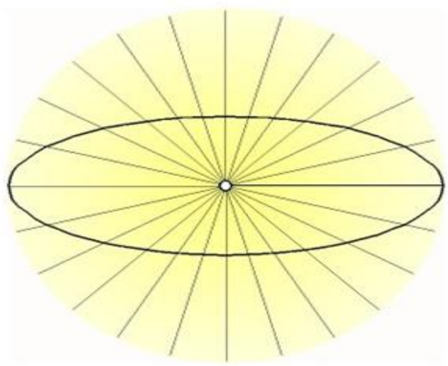


Fig 2.1 Spreading of point light source

The amount of total light output from a luminaries in a given time is expressed in lumens, which in turn is a measure of flux (F). Since actual sources of light are not omnidirectional, their radiance pattern is always specified by how many lumens are being emitted at a given angle in a specified direction. This quantity is called intensity (I) and is measured in lumens per steradian. The relationship between flux and intensity is demonstrated in the following equation:

$$I = F/4\pi \quad \text{…. Eqn. 2.1}$$

2.3 Lighting Engineering

There are several different types and designs of luminaries from which to choose. Some are clearly more energy efficient than others. Below are brief capsule summaries of the most popular types of light sources in use today.

2.3.1 Standard Incandescent Lamp

It is the most common interior light source in use today. The incandescent lamp produces light by passing an electrical current through a wire or filament. The filament's resistance to the flow of electrical current raises the filament to a high temperature, causing it to incandesce, or glow. Tungsten is used as a filament material, as no other substance is as efficient in converting electrical energy into light on the basis of life and cost. Despite its popularity, the operating efficiency of a standard incandescent lamp makes it a poor choice for illumination. A 100 watt lamp, which is rated at 1,750 lumens, has an efficacy of

$$K=1750lm/100w=17.5 \quad \text{…. Eqn. 2.2}$$

Tests measuring the life-cycle of such a lamp show that the average life expectancy is approximately 750 hours. Therefore, in an application that requires illumination 11.23 hours/day, the number of years a 100 watt standard incandescent lamp will operate will be:

$$\#Years= Life750/4100 \text{ hours/yr} = 0.2 \text{ Yr} \quad \text{…. Eqn. 2.3}$$

The low initial cost of incandescent lamps is more than offset by their short life and low efficacy. As a result, incandescent bulbs are not commonly used for roadway lighting. Instead, other, more efficient (and initially more costly) light sources are preferred.

2.3.2 Fluorescent Lamps

It were first shown at the 1938 World's Fair in New York. They operate by passing electrical current through a low-pressure atmosphere of argon to a small quantity of mercury droplets. The mercury vaporizes and, in the process, radiates ultraviolet energy. A thin chemical coating of phosphor on the inside of the bulb wall is excited into fluorescence by the ultraviolet radiation, producing visible light. Fluorescent lamps are very efficient at producing light. Recall from the example above, a 100-watt incandescent lamp is rated at 1,750 lumens. By comparison, a 40-watt fluorescent lamp is rated at 3,150 lumens. To calculate the efficacy of this lamp, we must also take the lamp's ballast into consideration. Assuming a single-lamp ballast that consumes 14 watts, the overall efficacy is:

$$K = 3150lm/14+40w = 58.3 \qquad \text{…. Eqn. 2.4}$$

The system's efficacy can be improved by using a two-lamp or three-lamp ballast. A two-lamp ballast (requiring 92 watts) increases efficacy to 68.5 lumens/watt, while a three-lamp ballast (consuming 140 watts) produces a system efficacy of 67.5 lumens/watt. Further, the life expectancy of fluorescent lamps is much longer than incandescent lamps. Typically, the 40-watt fluorescent lamp cited above has a life rating of 20,000 hours. Assuming an 11.23-hour/day operating period (equal to the previous incandescent example), the 40-watt fluorescent lamp will last:

$$\#Years = Life20000/4100 \text{ hours/yr} = 4.9 \text{ Yr} \qquad \text{…. Eqn. 2.5}$$

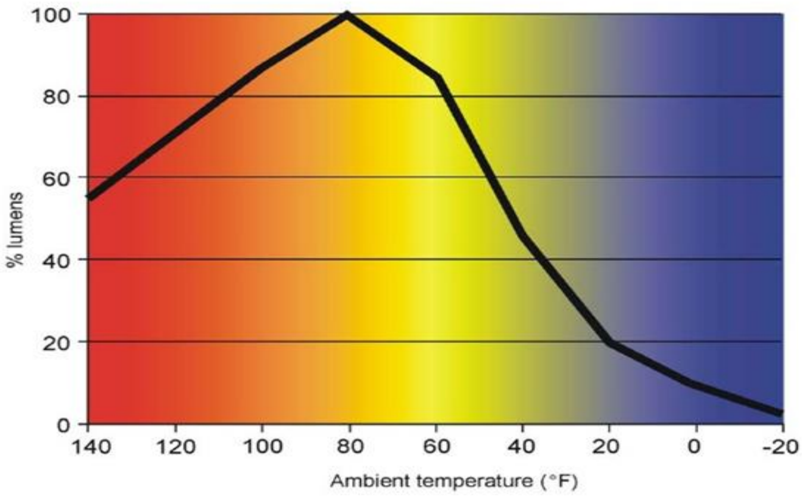


Fig 2.2 Effect of Temperature on CFL

Despite their attractive efficacy and life-cycle cost, fluorescent lamps are not generally used for exterior lighting. As Figure 4 demonstrates, fluorescent lamps are greatly affected by ambient temperature. The most efficient lamp operation is achieved when the air surrounding

the lamp is approximately 80° F. Far from this narrow temperature range and the lamps lumen output drops off rapidly, caused by a reduction in mercury pressure and subsequently, less ultraviolet radiation. While low-temperature ballasts are available for starting and operating fluorescent lamps as low as -20° F (by using a higher starting voltage), they do nothing to overpower the dramatic loss in light output.

2.3.3 Low-Pressure Sodium Lamps

No other lamp has as high an efficacy as the low-pressure sodium (LPS) lamp. LPS lamps have been used extensively as exterior light sources in Europe for the past half-century as well as in the United States, though on a much more limited basis. Light is produced in an LPS lamp by a U-shaped arc tube constructed of glass and filled with sodium gas as well as small amounts of neon and argon. Visible light is produced by electrons bombarding the sodium, resulting in monochromatic yellow light (primary wavelength = 589 nm). As noted previously, efficacy of LPS lamps is second to none. Table below itemizes the efficacy and lumens for several of the more popular LPS lamp in use today.

Table 2.2 Low-Pressure Sodium Lamp Efficacy

Lamp Wattage	Lumens	Efficacy (Lamp + Ballast)	Annual KWH Consumption	Annual Operating Costa
35	4,800	80.0	246	$15.99
55	8,000	100.0	328	$21.32
90	13,500	108.0	513	$33.35
135	22,500	126.4	738	$47.97
180	33,000	150.0	902	$58.63

Note: a. Assuming a cost per Kilowatt-Hour (KWH) of 6.5¢ (the power rate paid by Brookhaven National Laboratory, the case study).

Except for low-wattage (e.g., <35 watts) LPS lamps, all have a projected life cycle of 18,000 hours. Therefore, using the life-cycle equation from above, any of the LPS lamps specified in Table have a projected operational life of:

#Years= Life18000/4100 hours/yr = 4.4 Yr …. Eqn. 2.6

LPS lamps are not as affected by temperature extremes as fluorescent lamps. Manufacturers state that lumen output is constant over a temperature range of +14° F (10° C) to +104° F (+40° C) (the effect on lumen output beyond this range is undocumented).

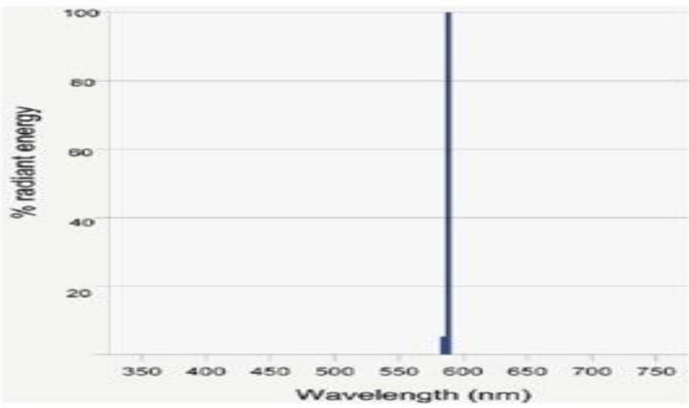


Fig 2.3 wavelength Distribution of LPS

Perhaps the biggest drawback to LPS lamps is their monochromatic yellow color. As shown in Figure, most of the light output is at a single wavelength of 589 nm. As a result, all nonyellow objects take on varying shades of gray or brown, greatly impairing the lamp's color-rendering potential. Depending on the application, this may make an LPS lamp less attractive than other sources with broader emission spectra.

2.3.4 Mercury Vapor Lamps

The arc tube, constructed of quartz, contains mercury as well as small quantities of krypton, neon, and argon. Upon energizing, an arc is struck between the lamp's main and starting electrode. This, in turn, ionizes the mercury to produce light at 405, 436, 546, and 578 nm, lending a bluish-green cast, as well as in the ultraviolet range. Frequently, a thin layer of phosphor is coated on the inside of the fixture, reacting with the UV radiation to offer a better balance in color.

Unlike that of LPS lamps, the efficacy of mercury-vapor lights varies widely with lamp wattage. In general, the greater the lamp wattage, the higher the efficacy, as shown in the examples cited in Table. From this, it can be seen that mercury-vapor lamps increase in efficacy as their wattage increases, but overall, they are less energy efficient than other LPS lamps as well as both metal halide and high-pressure sodium lamps (discussed below).

Table2.3 Efficacy of Mercury-Vapor Lamps

Lamp Wattage	Mean Lumens	Efficacy (Lamp + Ballast)	Annual KWH Consumption	Annual Operating Costa
175	7,140	35	841	$54.67
250	10,540	37	1,169	$75.99
400	18,570	41	1,866	$121.29
700	29,850	39	3,137	$203.91
1000	46,200	42	4,469	$290.49

Note: a. Assuming a cost per Kilowatt-Hour (KWH) of 6.5¢ (the power rate paid by Brookhaven National Laboratory, the case study).

#Years= Life20000/4100 hours/yr = 4.9 Yr …. Eqn. 2.7

2.3.5 High-Pressure Sodium Lamps

High-pressure sodium (HPS) lamps produce light when gas contained in an arc tube (in this case, sodium) is excited into fluorescence. As can be seen from Figure.(right), HPS lamps emit light across the visible spectrum. The majority of light generated falls between 550 nm and 650 nm, resulting in the lamp's characteristic orange cast.

In general HPS lamps enjoy both a high efficacy and long operating life.

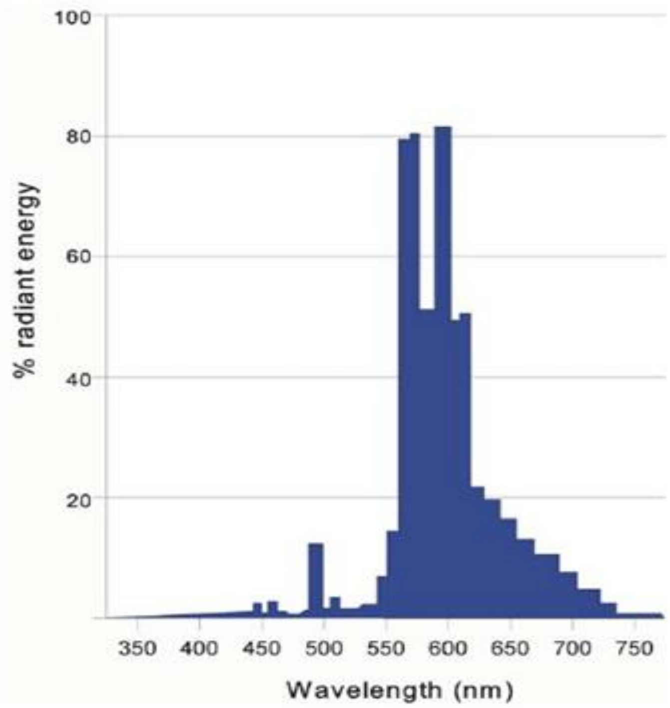


Fig 2.4 wavelength Distribution of HPS

Table 2.4 Efficacy of High-Pressure Sodium Lamps

Lamp Wattage	Mean Lumens	Efficacy (Lamp + Ballast)	Annual KWH Consumption	Annual Operating Costa
100	8,550	66	533	$34.65
150	14,400	75	791	$51.42
200	19,800	80	1,009	$65.59
250	24,750	84	1,205	$78.33
400	45,000	97	1,907	$123.96

Note: a. Assuming a cost per Kilowatt-Hour (KWH) of 6.5¢ (the power rate paid by Brookhaven National Laboratory, the case study).

#Years= Life24000/4100 hours/yr = 5.8 Yr …. Eqn. 2.8

This makes HPS lamps the longest lasting of any of the common types of lamps. This, combined with its high efficacy and low cost, has led to HPS lamps becoming the most popular type of exterior luminaries in use today.

2.4 Comparison Chart LED Lights vs. Incandescent Light Bulbs vs. CFLs

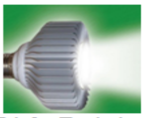
Energy Efficiency & Energy Costs	 **Light Emitting Diodes (LEDs)**	 **Incandescent Light Bulbs**	 **Compact Fluorescents (CFLs)**
Life Span (average)	**50,000 hours**	**1,200 hours**	**8,000 hours**
Watts of electricity used (equivalent to 60 watt bulb). LEDs use less power (watts) per unit of light generated (lumens). LEDs help reduce greenhouse gas emissions from power plants and lower electric bills	**6 - 8 watts**	**60 watts**	**13-15 watts**
Kilo-watts of Electricity used (30 Incandescent Bulbs per year equivalent)	**329 KWh/yr.**	**3285 KWh/yr.**	**767 KWh/yr.**
Annual Operating Cost (30 Incandescent Bulbs per year equivalent)	**$32.85/year**	**$328.59/year**	**$76.65/year**

Fig 2.5 Energy Efficiency and Energy Cost

Environmental Impact	 **Light Emitting Diodes (LEDs)**	 **Incandescent Light Bulbs**	 **Compact Fluorescents (CFLs)**
Contains the TOXIC Mercury	**No**	**No**	**Yes** - Mercury is very toxic to your health and the environment
RoHS Compliant	**Yes**	**Yes**	**No** - contains 1mg-5mg of Mercury and is a major risk to the environment
Carbon Dioxide Emissions (30 bulbs per year) Lower energy consumption decreases: CO_2 emissions, sulfur oxide, and high-level nuclear waste.	**451 pounds/year**	**4500 pounds/year**	**1051 pounds/year**

Fig 2.6 Environmental Impact

Important Facts	 Light Emitting Diodes (LEDs)	 Incandescent Light Bulbs	 Compact Fluorescents (CFLs)
Sensitivity to low temperatures	None	Some	Yes - may not work under negative 10 degrees Fahrenheit or over 120 degrees Fahrenheit
Sensitive to humidity	No	Some	Yes
On/off Cycling Switching a CFL on/off quickly, in a closet for instance, may decrease the lifespan of the bulb.	No Effect	Some	Yes - can reduce lifespan drastically
Turns on instantly	Yes	Yes	No - takes time to warm up
Durability	Very Durable - LEDs can handle jarring and bumping	Not Very Durable - glass or filament can break easily	Not Very Durable - glass can break easily
Heat Emitted	3.4 btu's/hour	85 btu's/hour	30 btu's/hour
Failure Modes	Not typical	Some	Yes - may catch on fire, smoke, or omit

Fig 2.7 Important Facts about Loads

Light Output	 Light Emitting Diodes (LEDs)	 Incandescent Light Bulbs	 Compact Fluorescents (CFLs)
Lumens	Watts	Watts	Watts
450	4-5	40	9-13
800	6-8	60	13-15
1,100	9-13	75	18-25
1,600	16-20	100	23-30
2,600	25-28	150	30-55

Fig 2.8 Analysis of Output

2.5 Design Considerations

In the past, designing exterior lighting was simple. The most common philosophy was to flood an area with as much light as practical, while giving little or no consideration to the system's efficiency or effectiveness. But in these energy-conscience times, this approach is both irresponsible and unnecessary [18]. Today, luminaries are designed to yield sufficient illumination across a target area while minimizing scatter, glare, and excessive power consumption. Unfortunately, it is not always easy to find these from among a market that continues to be dominated by poorly designed fixtures that are throwbacks to a more thoughtless age.

First, to design an efficient lighting system, it is necessary to understand why outdoor nighttime lighting is necessary in the first place. The purpose of outdoor lighting systems can be summed up in three basic goals:

i. Lighting of roadways and sidewalks for way-finding and object avoidance;
ii. Safety of users; and
iii. Security against vandalism, thievery, and other crimes.

Many urban and suburban areas assuming that if a little light is good[18], then more light is better. Studies by the International Dark-Sky Association and other agencies prove this to be a false assumption; indeed, too much light can be counterproductive. Many designers consider only quantity of light while ignoring quality.

A poor-quality lighting system will be plagued with overwhelming glare, wasted spill light (light trespass), and eclipsing shadows, all of which lead to poor transient adaptation. Direct glare is the major problem with most exterior lighting. Glare can cause annoyance, discomfort, and a loss of visibility. This results when a light source's luminance is much higher than the surroundings to which the eye has become accustomed, such as a brightly lit building set amongst dark surroundings.

Perhaps the most poignant example of these is seen while driving at night along a country road, when from around a bend, another car approaches. The overwhelming brightness of the car's headlights can temporarily blind the driver. This same effect can be witnessed when driving along poorly illuminated roads, alternately passing from under overly bright, ill designed lights to areas of comparative darkness. In cases such as this, the eye will never becomes adjusted to the changing conditions. While glare and light spill can never be completely eliminated, well-designed fixtures with full cut-off shielding will go a long way to minimize the effect.

2.6 Top 10 Energy Benefits of Light Control

With Lutron light controls, we can save energy AND improve your working environment and quality of life at home. The following text describes a list of 10 eco-friendly facts about light management solutions that are often overlooked.

2.6.1 Light Control Increases Comfort and Improves Productivity.

Our energy-saving light controls provide a comfortable and productive visual environment. Enhancing the comfort levels of a space leads to increases in productivity. Through our Total Light Management™ solutions, better lighting not only can reduce the energy consumption of a room, it can improve the quality of work from its occupants.

Table 2.5 One Year Incandescent/Halogen Energy Savings Chart

dimming the lights	saves electricity	bulbs last on average	annual savings†
10%	10%	3 years	$9.70
25%	20%	3-6 years	$17.30
50%	40%	10+ years	$30.00

2.6.2 All Dimmers save Energy.

Every dimmer automatically saves 4-9% in electricity—even at the highest lighting levels—over a standard on-off switch. And when users choose to dim their lights, even more electricity is saved. Quite simply, the more you dim, the more you save. A standard light switch only saves electricity in the "off" position. Dimmers and controls save energy 24-7.

2.6.3 All Light Sources Use Less Energy When Dimmed.

While incandescent lights are typically associated with dimming, all lighting sources, including halogen, CFLs, and, LED bulbs, can be dimmed. For example, a halogen light source dimmed 35% reduces energy use by 28%. On average, dimming an incandescent or halogen light will reduce energy use by about 20%.

2.6.4 Dimming Saves Energy and the Environment While Enriching Your Life.

While there are many ways to reduce energy use, most involve sacrificing something. Few actually enrich the quality of living and working environments like dimmers. Dimmers and other lighting controls allow individuals to adjust light levels for specific entertainment options, enhance ambiance, set a mood, and take advantage of daylight to reduce energy use.

2.6.5 Using Dimmers Saves Money.

Using a Dimmer in your home in place of a standard switch on an incandescent bulb can result in yearly energy saving of approximately $8.00. If the light is dimmed 50%, and if you take into account the extended life of the bulbs, you can experience up to $30 in annual savings.

2.6.6 Shading Solutions are also Energy Efficient.

Shading systems save energy by harvesting daylight and reducing the load on HVAC systems, making any project more eco-friendly. Shading can also be made from eco-friendly materials. Sustainable materials are either PVC-free or are 100% recycled.

2.6.7 If Every US Homeowner Changed 2 Light Switches to a Dimmer

Lurton estimates that by installing just two dimmers in place of two standard light switches in every home in the US, the potential annual savings could be $1.5 billion in electricity and close to 25 billion pounds of CO_2—the equivalent to taking more than 1 million cars off the road.

2.6.8 Lurton Systems can automatically save Money and Energy.

Automated systems like daylight and occupancy sensors and the time clock can turn on lights according to changes in light or the time of day. Without any input from the user, Lurton systems can reduce energy costs and usage.

2.6.9 All Lurton Dimmers Extend Bulb Life.

Dimmers reduce power to the lighting source or bulb, so they save energy and extend bulb life. Incandescent and halogen bulbs last up to 20 times longer when used with a dimmer, increasing the money saved.

The **'Bichat Lamp Yojana'** aims at the large scale replacement [20] of incandescent bulbs in households by CFLs. It seeks to provide CFLs to households at the price similar to that of incandescent bulbs and plans to utilize the Clean Development Mechanism (CDM) of the Kyoto Protocol to recover the cost differential between the market price of the CFLs and the price at which they are sold to households.

2.7 Merits of LED lamps & demerits of filament lamps

2.7.1 Demerits of Conventionally filament lamps are as follows:

- High energy consumption (15 watt/lamp).
- Failure of lamps is high (operating life less than 1,000 hours).
- Very sensitive to the voltage fluctuations.

2.7.2 Merits of the LED lamps over conventionally filament lamps are as follows:

- Lesser power consumption (0.5-0.8 watt/lamp).
- Longer operating life (more than 1, 00,000 hours).
- Withstand high voltage fluctuation in the power supply.

2.8 Merits of high frequency electronic ballasts over conventional Magnetic ballasts

- Energy savings about 30 to 50 %.
- Lights instantly.
- Improved power factor (more than 0.90 power factor).
- Less heat dissipation, this reduces the air conditioning load.
- No audible humming sound.
- No stroboscopic effect.
- Operates in low voltage.
- Less in weight.
- Increases the life of lamp

2.9 Characteristics of light source

- Efficacy
- Color rendering
- Color temperature
- Size
- Life
- Cost

2.10 Factors affecting the lighting system design

- Use of high efficacy light source
- Use of more efficient luminaries
- Selective switching
- Utilization of daylight
- Luminaries of higher space to height ratio
- Higher reflectance surfaces of the room
- Visual task analysis
- Task oriented lighting.

2.11 Energy conservation in lighting system

- Use of LED lamps for indicating lamps will reduce the energy consumption.
- Use of compact fluorescent lamps in place of incandescent lamps, reduce the lighting energy by 70%.
- Use of mirror optic fluorescent lamps increases the lighting level considerably.
- Use of HPSV lamps in place of MPSV lamps reduce the energy consumption by 60%
- As the lighting level is inversely proportional to square of the distance, optimizing the height of lamp will aid in reduction of lighting energy.
- Use of electronic ballasts for discharge lamps, reduce energy consumption by 20%
- Installation of intelligent lighting controller will help in controlling the lighting energy.
- Use of photo sensor switch for street light controlling helps in conserving the lighting energy.
- Installation of auto cut-off switch to put off lights during lunch hours at the office buildings will reduce the lighting energy.
- At street lights, in many places, the reflectors inside the HPSV fitting are damaged; it is suggested to replace the fittings with anodized aluminum reflectors. This will improve the lighting level by 20-25%.

2.15 Benefits of using LED light bulbs over standard light bulbs

- Power consumption of LED light bulb is only 10% of the standard light bulb.
- LED light bulbs withstand great amount of vibration, shock and temperature variations.
- LED light bulbs are 10-60 times more energy efficient than incandescent light bulbs.
- Incandescent light bulbs produce light that flickers whereas LED light bulbs produce flicker free light.
- LED bulbs can produce many rich and vibrant colors when compared to incandescent light bulbs.

2.16 Key Product Features of LED light bulbs

- Low electrical consumption as compared to conventional lighting products.
- Pollution free due to non-emission of infra red or ultraviolet rays, mercury gases or other harmful rays.
- Do not have ballasts thus, no interference Existing fixtures used since long are used making installation of our lights easy.
- Operates on universal input range.
- Due to long shelf life, no maintenance is required.
- Lasts 5 to 10 times longer than other conventional lighting products virtually eliminating the need for frequent replacement.
- Reduces Carbon Footprints at large scale making it viable to earn carbon credits.
- Suitable for all types of applications.

2.17 Changing Scenario of Lamps

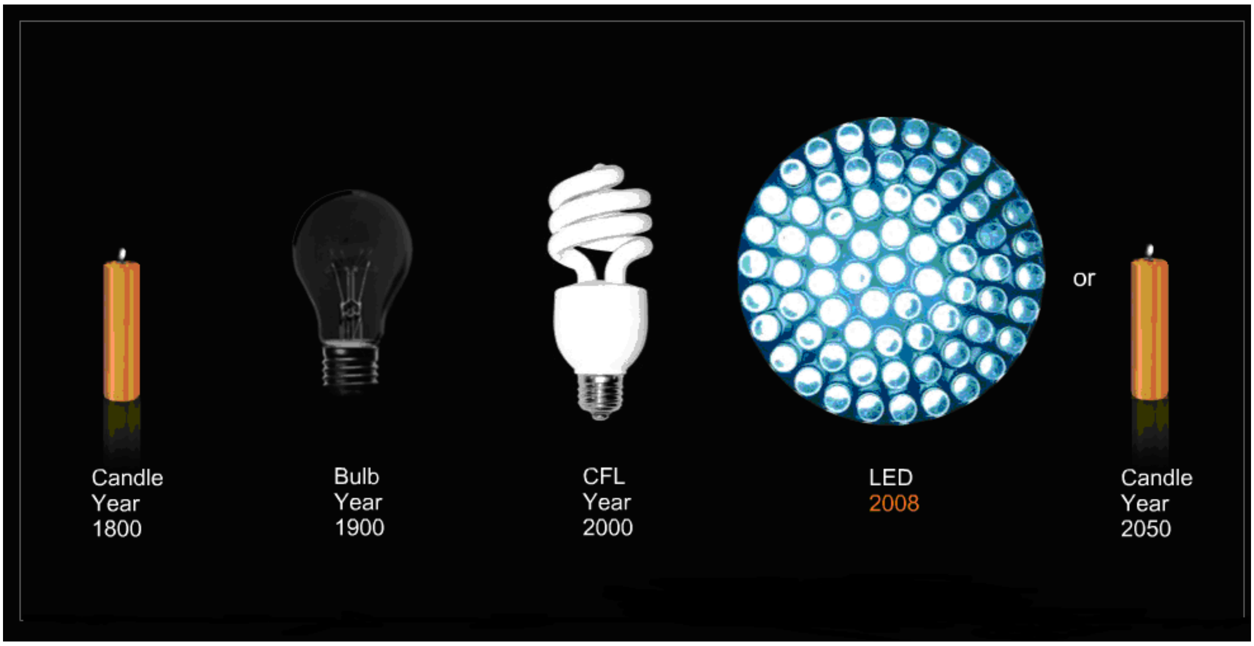
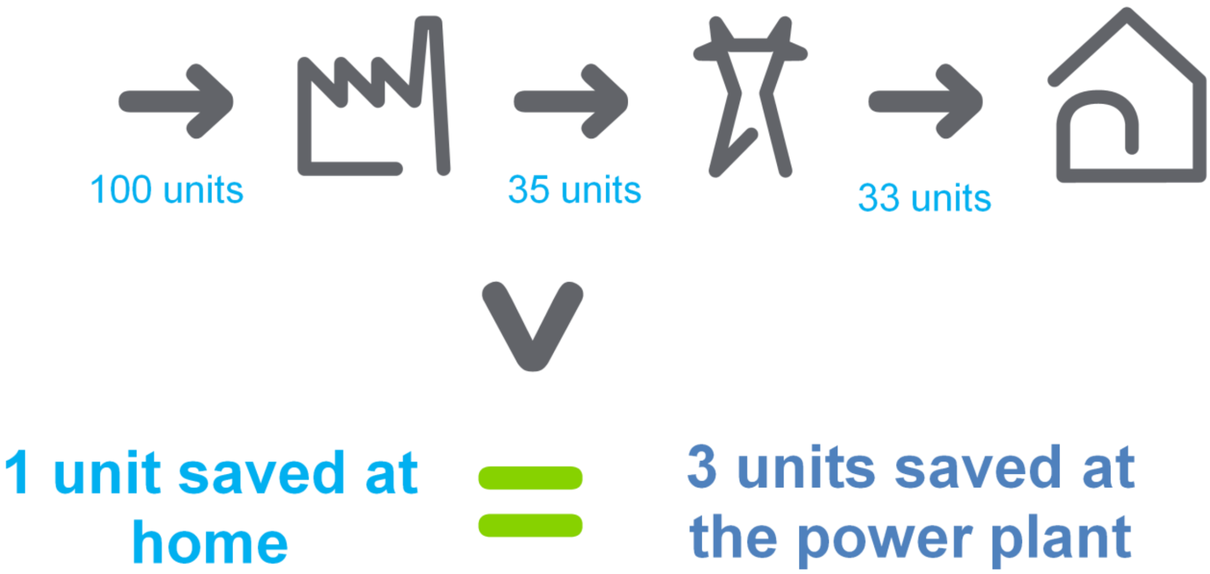


Fig 2.9 Evolution of light Source

We cannot stop world population or energy demand growth…But we can change the way we use energy and reduce GHG emissions [22]. A small save at home is a big save at the power plant!



2.18 Energy demand

The energy consumption of a building is influenced by many different quantities. They can be divided into four groups:

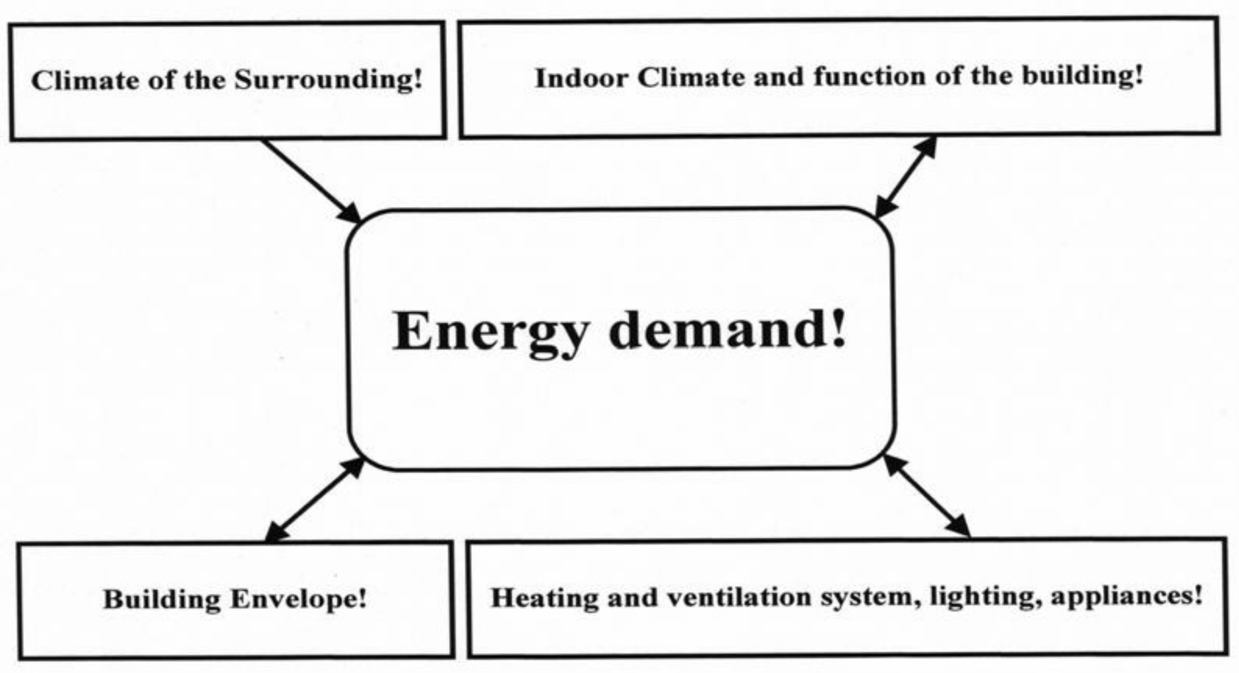


Fig 2.10 Energy Demand of building

Since the oil crisis of the 1970's, the world has become painfully aware that our planet has a finite and exhaustible amount of natural resources. As a result, we now see more energy-efficient automobiles, electrical appliances [21], and over conservation-oriented devices aimed to curb our energy-thirsty society. Yet, each year throughout the civilized world, untold megawatts of electrical energy is needlessly wasted by poorly designed, over-powered, and ill-placed lighting fixtures. While the aim of a lighting fixture should be to aim its light down toward the ground, many fixtures lose as much as half of their light skyward.

Have you ever noticed, as you are driving toward a large metropolitan area, how lights from the city seem to illuminate the sky even while you are still many miles away? This effect, called light pollution, is the cumulative result of hundreds[23], thousands, even tens of thousands of poorly designed and improperly placed streetlights, billboard and roadside lights, commercial and industrial building lights, and residential lights. The International Dark-Sky Association (IDA) estimates that as much as fifty percent (50%) of the light generated by nighttime lighting fixtures is wasted as it shines skyward, rather than down toward the ground where the illumination is desired but the present day awareness of energy conservation has created a need to use nighttime light wisely and efficiently.

The efficient and effective use of outdoor lighting can offer major energy and cost savings. New, much improved light fixtures, or luminaries, are now available which provide considerably more light per unit of energy consumed. Most new fixtures offer better light control, aiming the light downward toward the ground where it is needed rather than wasting it by letting it scatter upward and skyward. Replacement of older fixtures with new luminaries can greatly improve efficiency.

2.19 A day in the life of an office

Using occupancy sensors, daylight sensors, controllable shades, time clocks, and/or manual controls, Programmable light Control System reduces lighting energy usage typically by 60%.

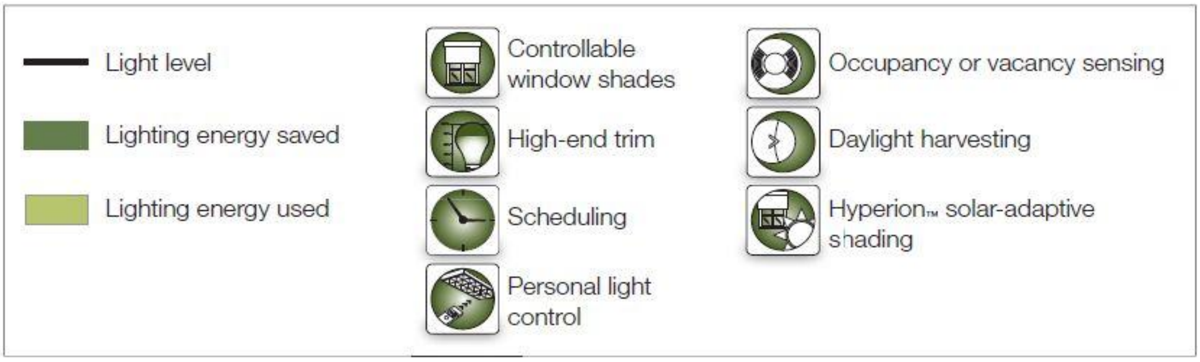


Fig 2.11 Devices Used for Home automation

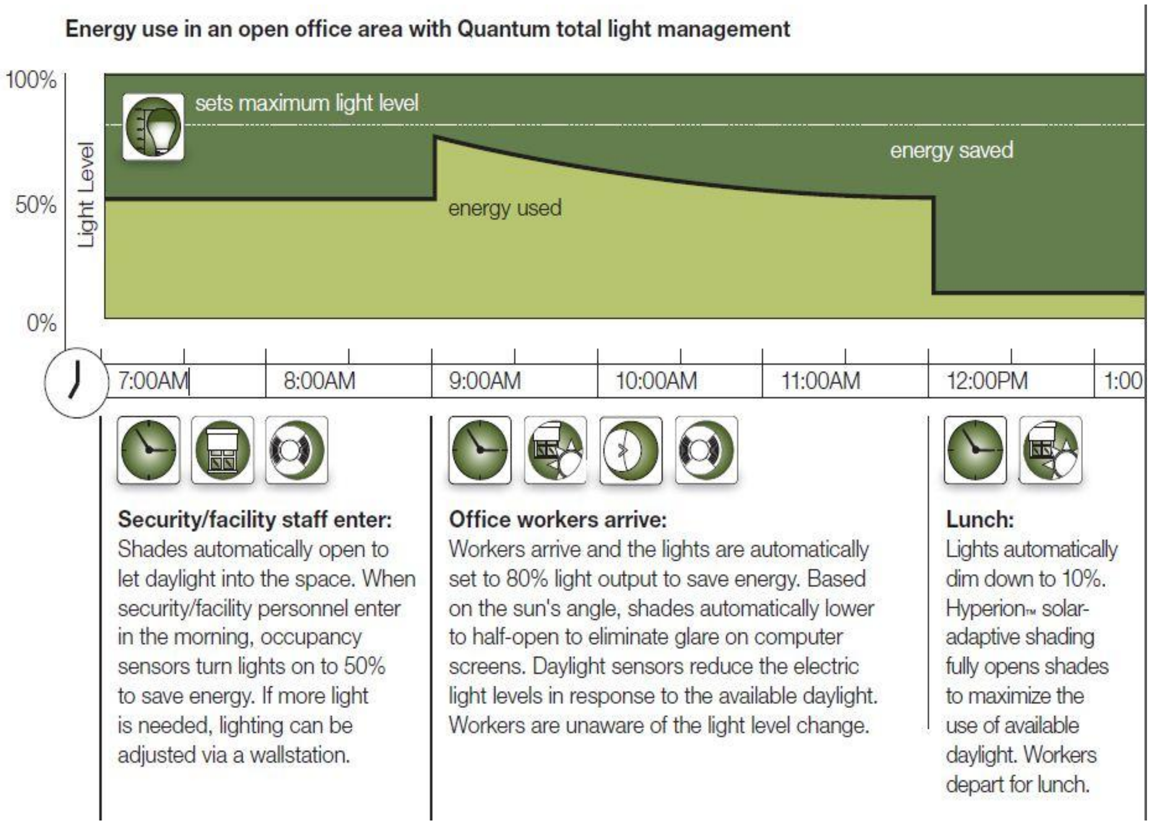


Fig 2.12 Light management in office

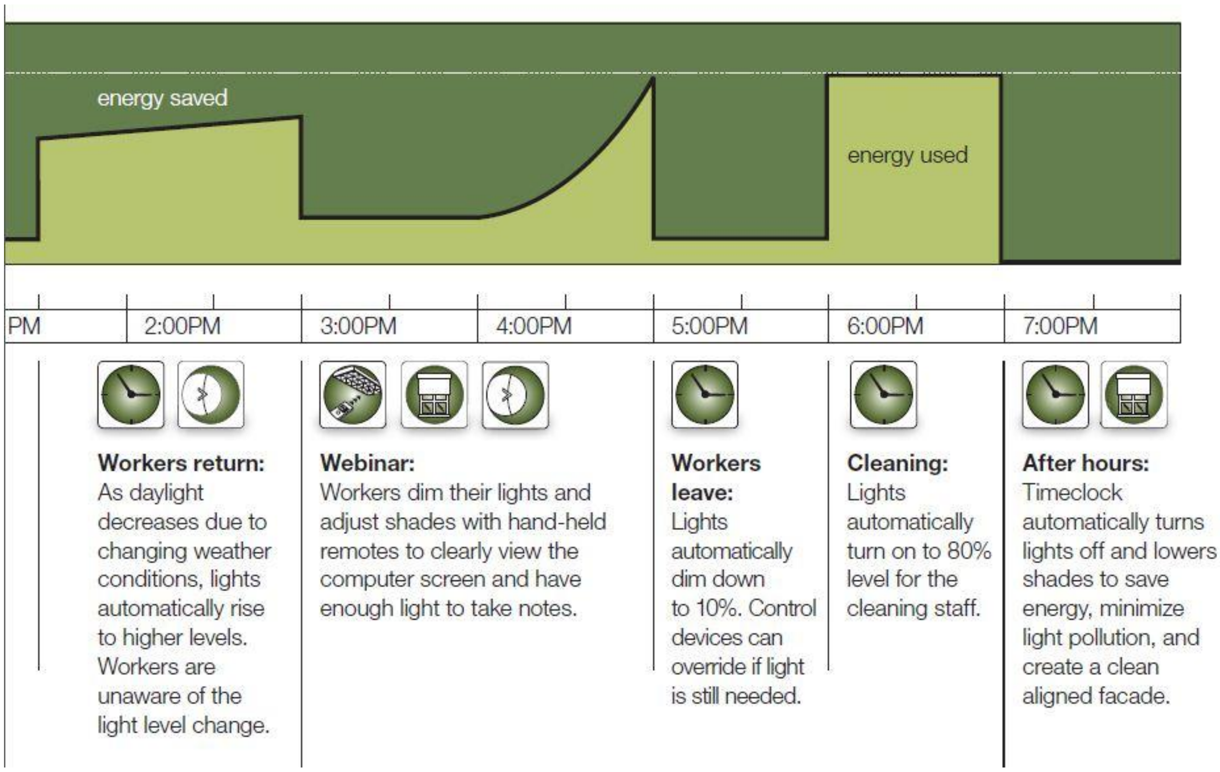


Fig 2.13 Light management in office after lunch

2.20 Hyperion solar-adaptive shading

2.20.1 What is Hyperion?

Hyperion is an automated shading system that adjusts shades throughout the day based on the sun's position. It maximizes functional daylight in a space while minimizing glare and solar heat gain to create a comfortable work environment. Hyperion can function as a stand-alone system or as a key feature of the Total Light Management system.

2.20.2 Why do we need Hyperion?

As the Earth orbits around the sun, the angle and intensity of available daylight changes along with the seasons. Thus, effective daylight management requires that shades on each building façade receive a unique schedule of positions for every day of the year.

2.20.3 about Hyperion

Hyperion uses advanced solar tracking technology. This means that Hyperion does not need sensors to locate the sun; instead, it uses a set of astronomical equations to calculate the sun's position each moment of every day. By calculating the sun's exact position, a schedule can be developed to accurately manage shade positions on each façade. This maximizes effective daylight while reducing the amount of heat and glare entering the space.

2.20.4 Cloudy day scenario

Hyperion uses an astronomical clock and the geographic location of a building to accurately adjust shades to account for the position and intensity of the sun throughout the day. The unpredictable fluctuations of daylight due to clouds and weather can be accounted for by adding the external roof-mounted Cloudy Day Sensor to the Hyperion software. When the daylight level no longer affects interior lighting, scheduled Hyperion shade movements will be paused and all shades will be sent to a "visor position." If the daylight level returns again, Hyperion will activate and the shades will resume normal scheduled operation. By combining the astronomical clock of Hyperion with an external sensor, daylight will be harvested more efficiently.

2.20.5 How does Hyperion work?

The system operator inputs the desired sunlight penetration distance into the building and the number of shade preset positions. Then, Hyperion solar-adaptive shading automatically calculates the angle of the sun and adjusts the shades to maintain the preferred light penetration.

At night the shades are lowered to minimize light pollution and provide a uniform appearance with precision alignment. The system also provides the ability for the user to manually override and adjust the shades to a custom level.

2.20.6 Seasonal solar variation

The position of the earth relative to the sun changes throughout the year. Consequently, the sun will be in a different position at noon on June 21st than it is at noon on December 21st.

Hyperion effectively manages daylight entering the space by incrementally changing the shade adjustment schedule of each façade on a daily basis, maximizing comfort and productivity.

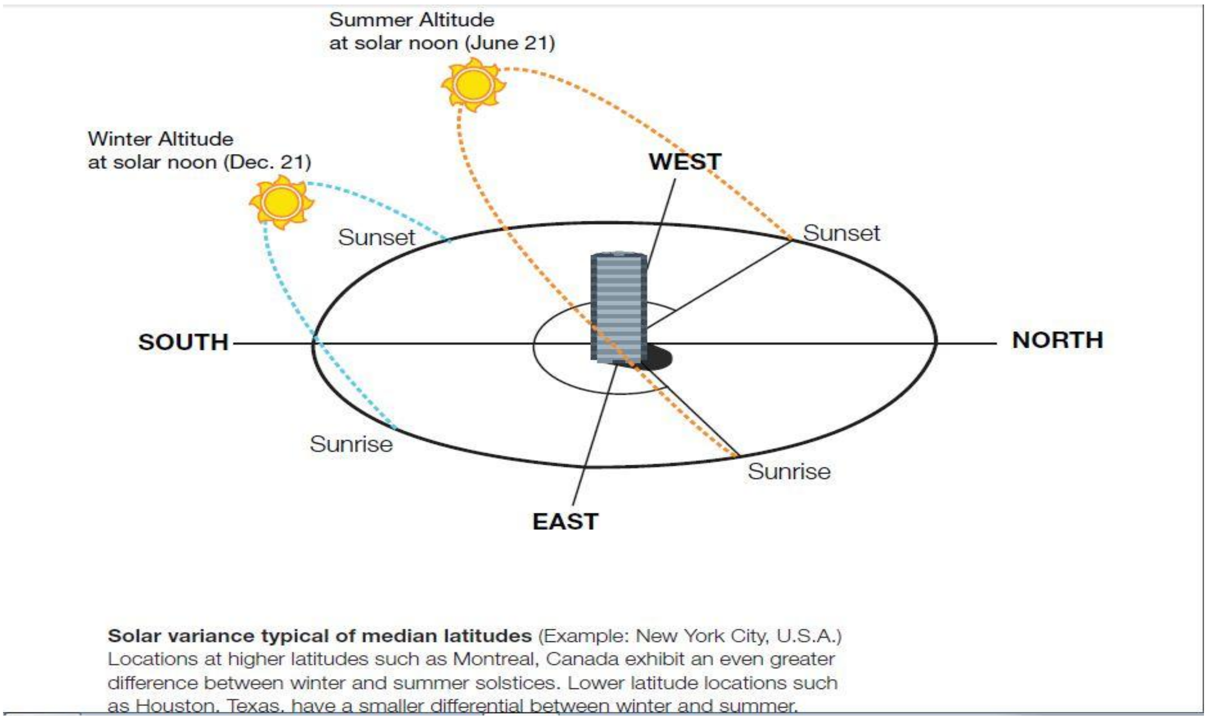


Fig no 2.14 Hyperion Algorithm Latitude

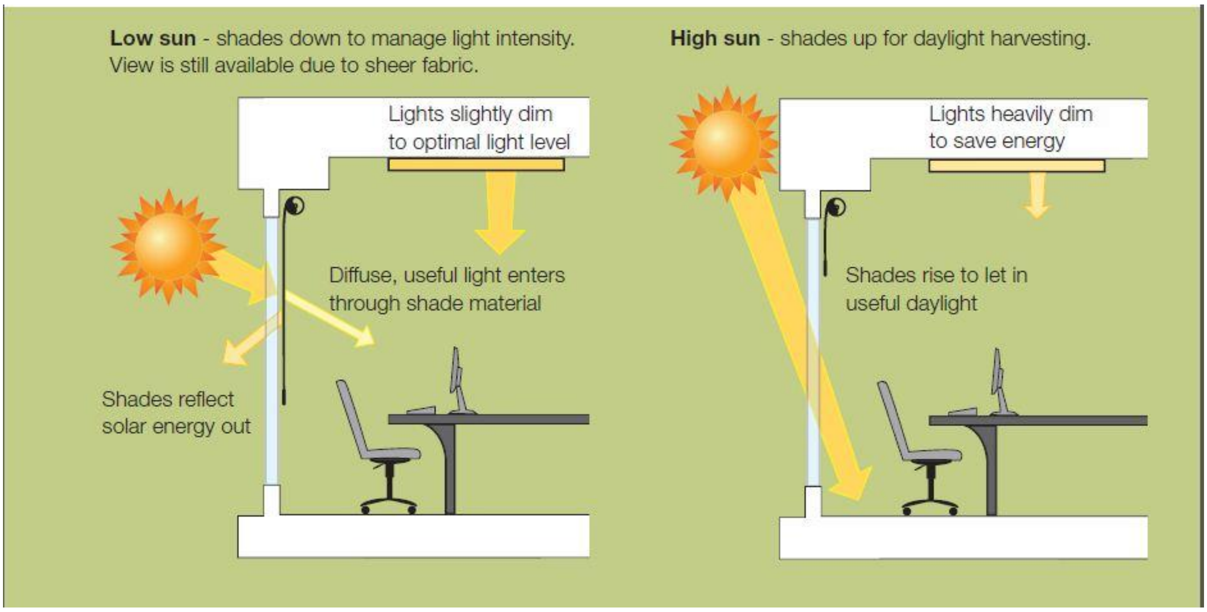
Fig no 2.15 Inefficient Daylight Management

Fig no 2.16 Efficient Daylight Mgt

Before: The afternoon sun makes it difficult to work productively due to heat and glare in the space.

After: With Hyperion solar-adaptive shading, the window shades automatically close when the sun reaches a critical angle – making the space more comfortable by reducing glare and heat While maintaining the view outside.

Energy conservation



2.21 The human element

People react to daylight in a number of ways. Consequently, daylight can have a profound impact on their comfort and productivity**.**

2.21.1 Physical

Our biological clock is regulated by daylight. The eye responds to a blue wavelength found in daylight that office lighting cannot reproduce. Without sufficient access to this wavelength, the body has difficulty maintaining its natural cycle —impacting alertness and health [27].

Hyperion generates a shade schedule that permits an effective amount of daylight to enter the workplace.

2.21.2 Psychological

Preservation of outdoor views has a positive effect on occupants. Workers with views perform better on tests than those without any scenery. Also, many people believe that working in daylight is better for health and well-being than electric light. Therefore, the visual environment can significantly influence a worker's mood and perception of the quality of his or her job [27].

Hyperion's automatic shade adjustments provide sufficient exterior views to maintain a connection with the outdoors.

2.21.3 Visual

Uncontrolled daylight can produce solar heat gain and excessive glare, causing eyestrain, Visual discomfort and subsequent headaches. Such conditions may drive employees to break from their tasks and have been shown to increase error rates [27].

Hyperion controls glare and properly diffuses daylight to create a comfortable and productive working environment.

CHAPTER 3
PROBLEM STATEMENT

Optimize electric light and daylight to save energy and create a productive, comfortable, visual environment.

Most buildings today are over-lighted because there is enough daylight in the space; or lights are set to a higher level than appropriate for the people inside; or spaces are lighted even though they are unoccupied. This wastes energy, creates discomfort, and reduces productivity.

It is an important issue to develop a computer program, which can help us in effective and efficient lighting system. This problem can be generalized as –

INPUT: Different parameters such as

1. Light level
2. Time schedule
3. Geographical Location of the Building
4. Scene

OUTPUT: The desirable output would be use proper lighting which will save energy but at the same time is also convenient to the user.

So, we can define the objective of the work can be defined as:

To make use of computer program in order to achieve efficient lighting.

CHAPTER 4

DESIGN AND EMPLEMENTATION

4.1 What is WPF? [30]

Windows Presentation Foundation (WPF) is a next-generation presentation system for building Windows client applications with visually stunning user experiences. With WPF, you can create a wide range of both standalone and browser-hosted applications. The core of WPF is a resolution-independent and vector-based rendering engine that is built to take advantage of modern graphics hardware. WPF extends the core with a comprehensive set of application-development features that include Extensible Application Markup Language (XAML), controls, data binding, layout, 2-D and 3-D graphics, animation, styles, templates, documents, media, text, and typography. WPF is included in the Microsoft .NET Framework, so you can build applications that incorporate other elements of the .NET Framework class library.

4.2 Markup and Code-Behind

WPF offers additional programming enhancements for Windows client application development. One obvious enhancement is the ability to develop an application using both markup and code-behind [31], an experience that ASP.NET developers should be familiar with. You generally use Extensible Application Markup Language (XAML) markup to implement the appearance of an application while using managed programming languages (code-behind) to implement its behavior. This separation of appearance and behavior has the following benefits:

- Development and maintenance costs are reduced because appearance-specific markup is not tightly coupled with behavior-specific code.
- Development is more efficient because designers can implement an application's appearance simultaneously with developers who are implementing the application's behavior.

4.3 Markup and Code-Behind

Markup

```
<Window
    xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
    xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
    x:Class="SDKSample.AWindow"
    Title="Window with Button"
    Width="250" Height="100">

  <! -- Add button to window -->
  <Button Name="button" Click="button Click">Click Me!</Button>

</Window>
```

Code-Behind

```
Using System. Windows; // Window, RoutedEventArgs, MessageBox

namespace SDKSample
{
    public partial class AWindow : Window
    {
        public AWindow()
        {
            // InitializeComponent call is required to merge the UI
            // that is defined in markup with this class, including
            // setting properties and registering event handlers
            InitializeComponent();
        }

        void button_Click(object sender, RoutedEventArgs e)
        {
            // Show message box when button is clicked
            MessageBox.Show("Hello, Windows Presentation Foundation!");
```

```
        }
    }
}
```

The following figure shows the result when the button is clicked.

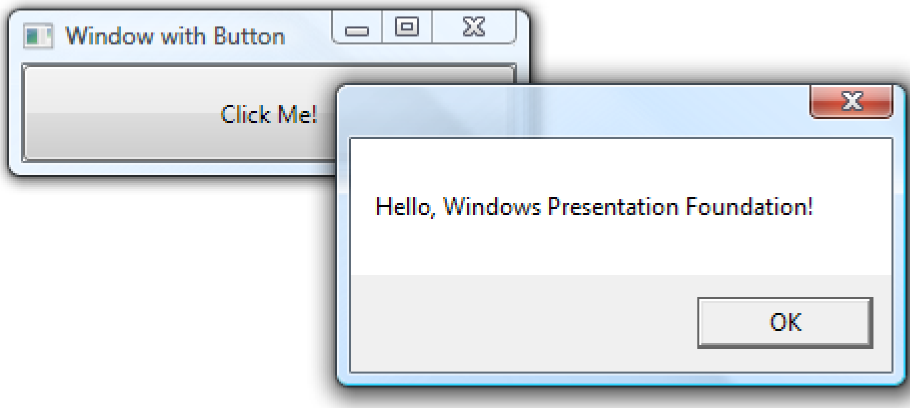


Fig 4.1 Output of simple XMAL code

4.2 Step by Step Description

Step 1: Create a new Project

This is the first screen which shows on the startup of the project. There are two option either create a new project or open a old project. If we select an old project then project basic information need not to fill otherwise we have to fill project basic information like location, color of the loads etc.

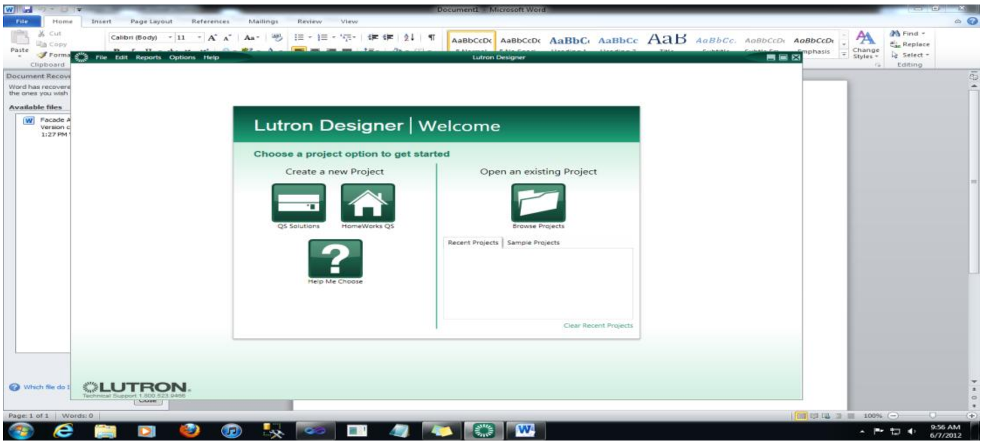


Fig 4.2 Create new Project

a. Project Location

In this tab location of the project is being set. In Location setting we set Country, State and City of the building where this project is being used. Based on this information software automatically find the geographical location like latitude, longitude and time zone of the building.

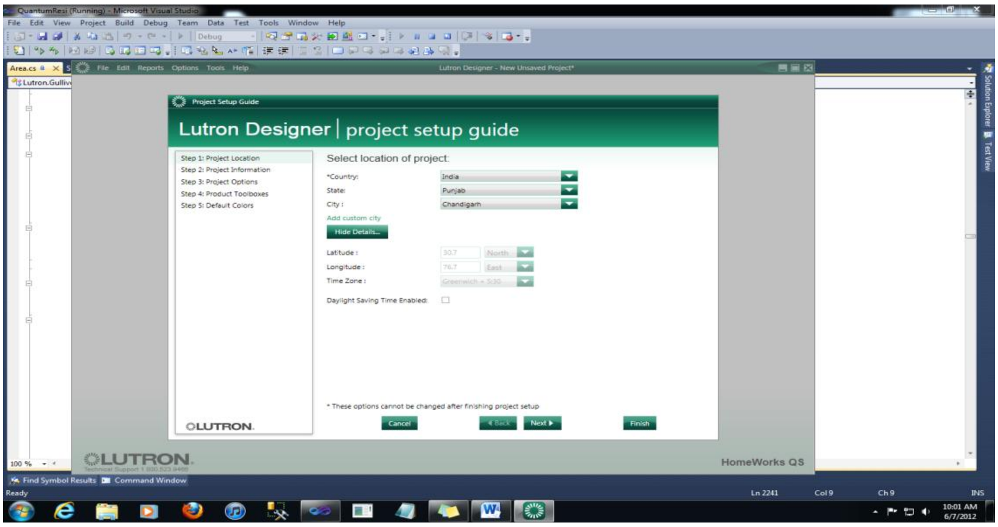


Fig 4.3 Project location

b. Project Information

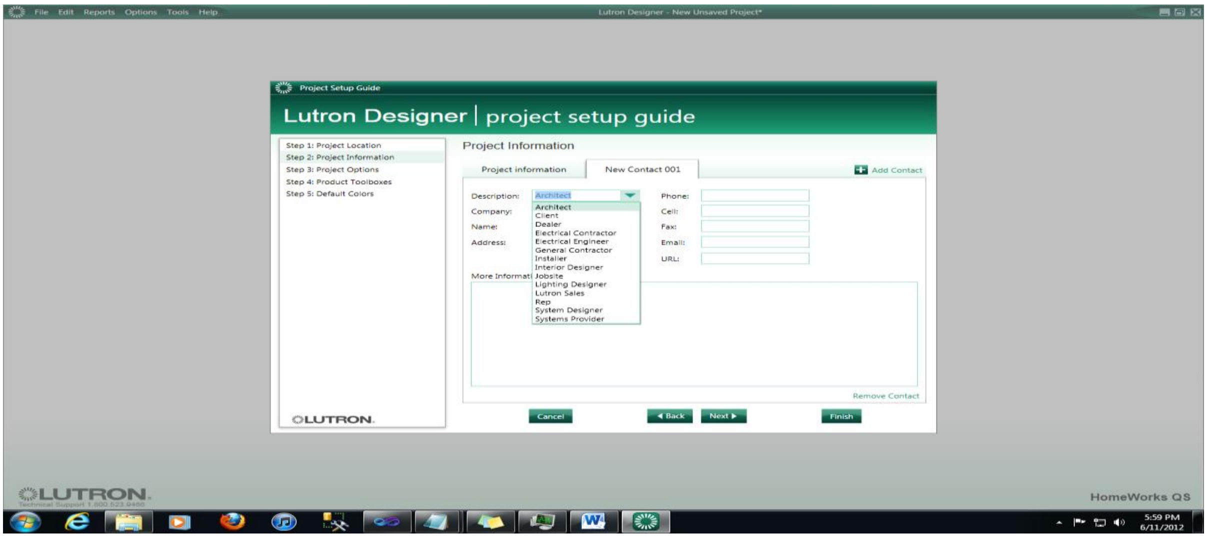


Fig 4.4 Project Information

c. Project Option

In project option we set the optional parameter like Power setting, Currency setting and Regional setting. Different Country have different Voltage level on which devices will be operated like in India devices operate on 220 Volt but in US Devices operate on 120 volt. Same case with the Radio frequency, different country operates on different frequency.

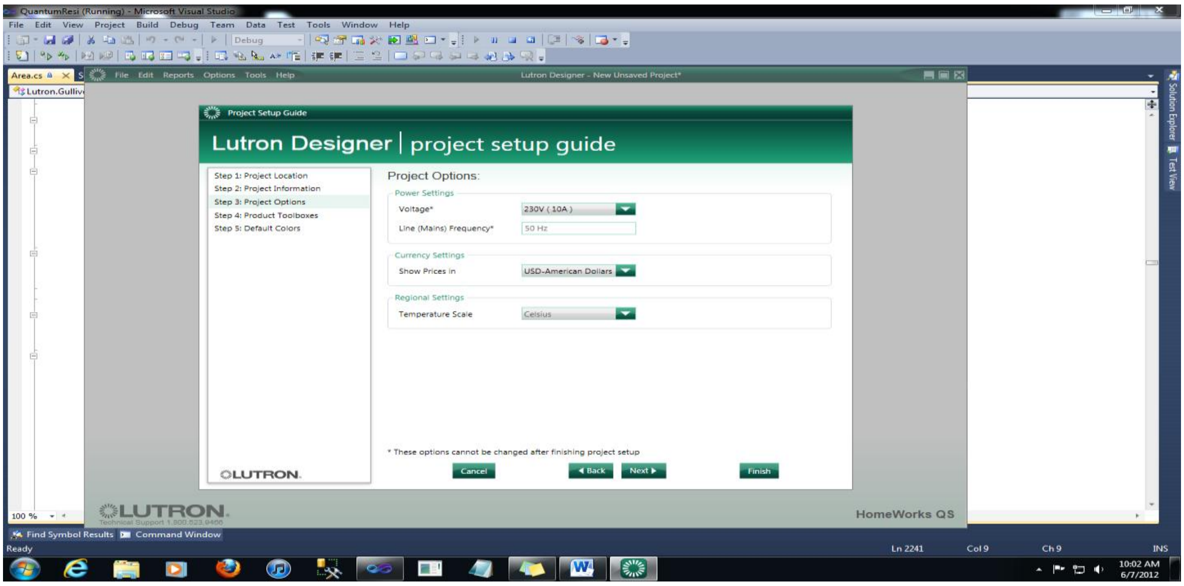


Fig 4.5 Project options

d. Project Toolbox

This tab contains the tools (Loads and equipments) which are being used throughout the project development. This is same as most of the IDE provide tool bar for controls to design GUI. There is a facility to add and remove devices from the toolbox.

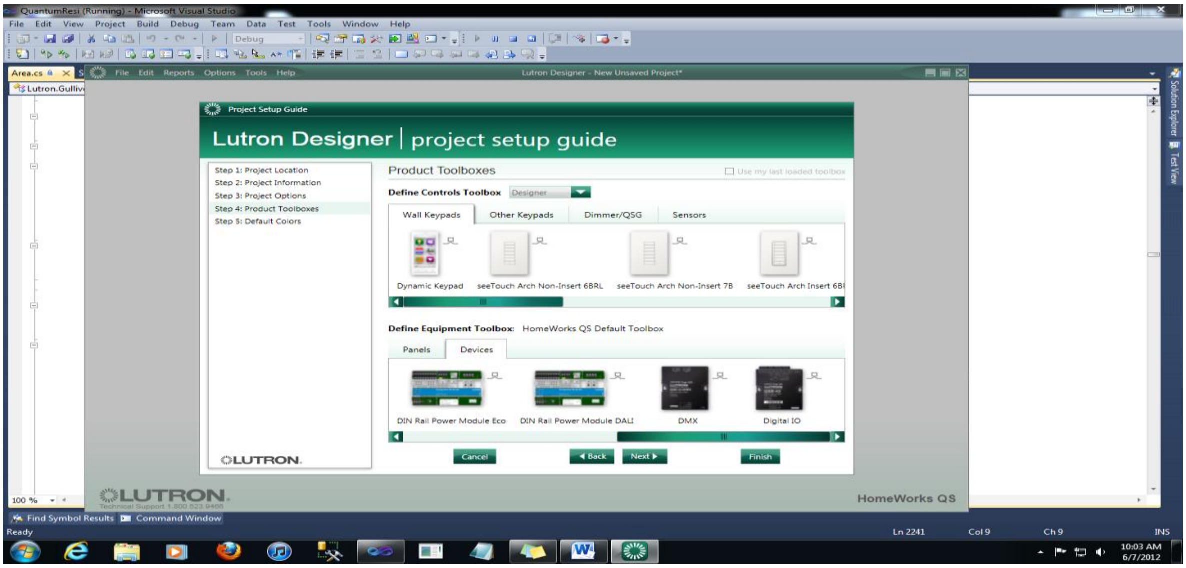


Fig 4.6 Project Options

e. Default Color

This tab is being use for selection color of the devices. Different house owner have different choice of colors. House owner can select color according to the color of the wall or the color they desired for. There are variety of color options are available here.

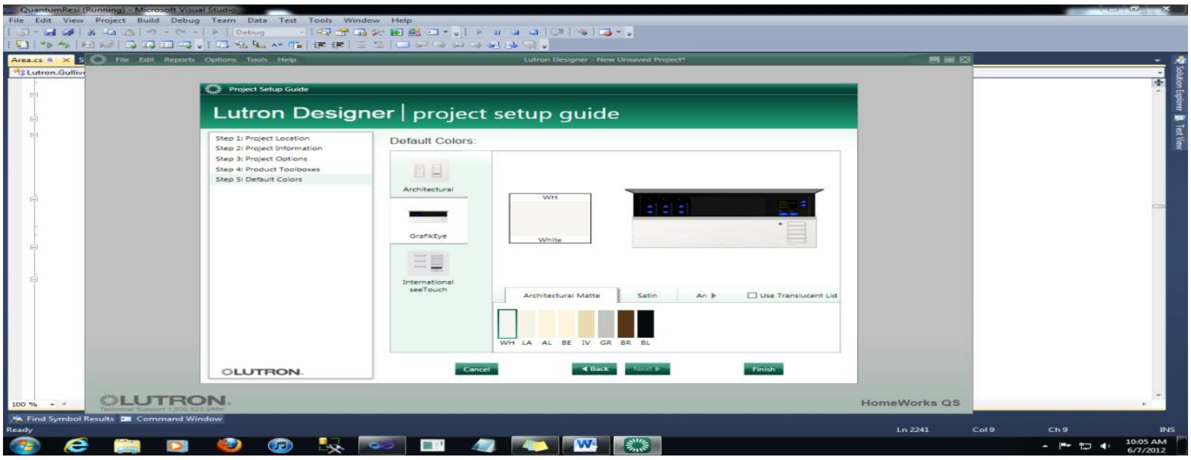


Fig4.7 Color of the Project

Step 2: Design

a Design Home Architecture

In this tab we specifies the architecture of the building like how many room in the house and what is the major areas in the building and subareas in the building it help us in designing the Loads and Equipments requirement in the building. It also helps where we need to put which load or equipment. Home architecture is the hierarchical design in which root level area is the building itself and then child area are master Bedroom, Kitchen, Reading room etc. The smallest controllable unit is the Zone.

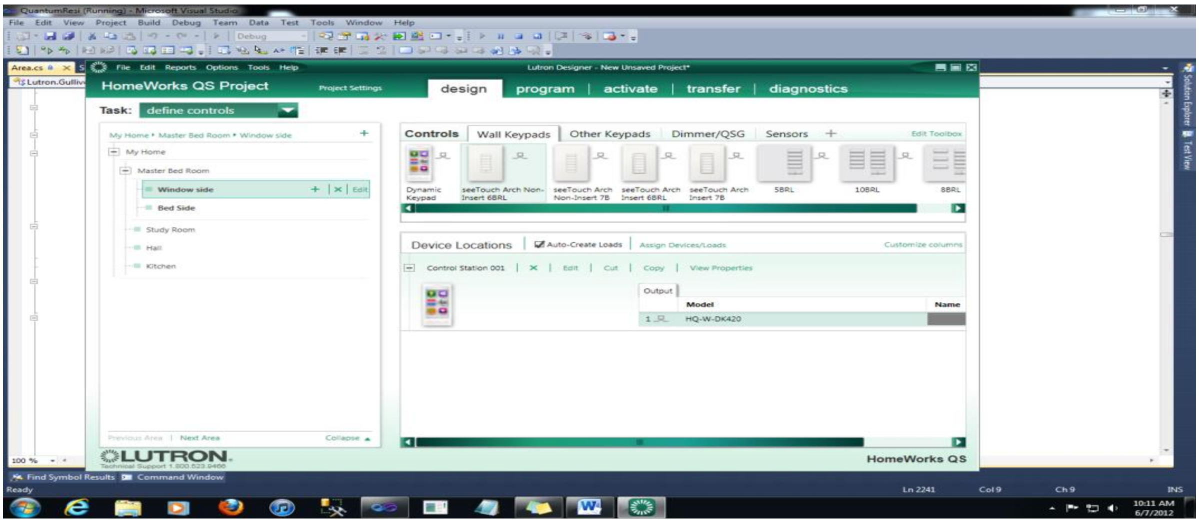


Fig4.8 Home Architecture

b. Define Controls

After designing the home Architecture we are almost clear about the requirement of the devices which are being used in the home. Now select a leaf area from the left panel as shown in figure given bellow and then select the controls which we need to have in the area.

Example: Suppose we want a 5 button keypad in my room, one Daylight sensor and one occupancy sensor then we will add these controls to our area(room). There are some additional controls which can be added to the Project.

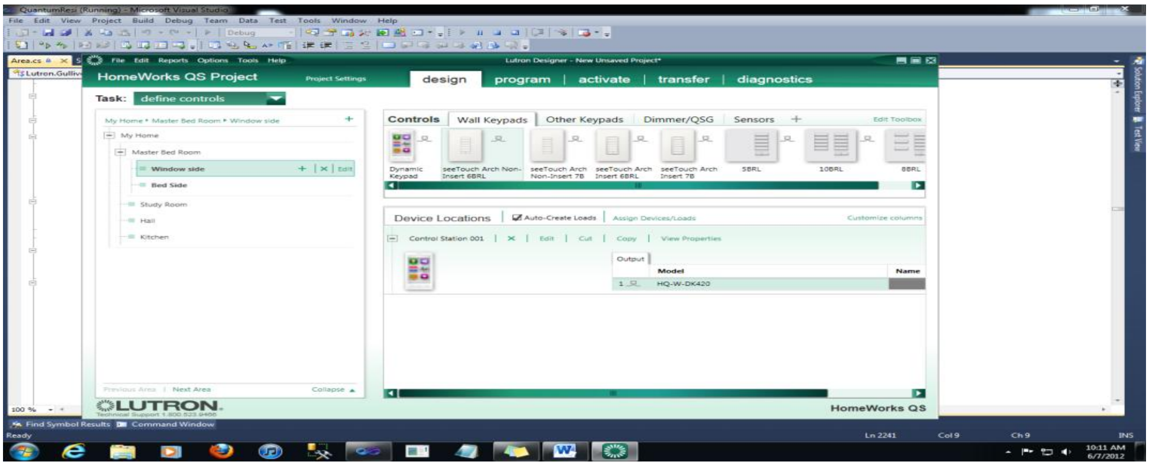


Fig4.9 Define Controls

Different Type of Controls are

Dimmers and Switch

Fig 4.10 Dimmer & switch

Push-button returns light to your favorite level Slide adjusts light to suit any activity Installs like a standard switch Available in 3-way models when the lights are controlled from more than one location Matching Claro® gloss or Satin Colors® wallplates available for 1-gang up to 6-gang sizes Also available with eco-dim® feature (dimmer guarantees you at least 15% energy savings compared to a standard switch) C•L™ models for dimmable CFL and LED bulbs are available; these models have HED™ Technology, which improves dimming performance of these bulbs

Radio Shadow™ sensor Total Light Management™ system

Fig4.11 Shadow sensor

The Radio Shadow Sensor is a new addition to the Quantum Total Light Management™ system. Working in conjunction with Hyperion solar-adaptive technology, the new Radio Shadow sensor maximizes views as well as available daylight by compensating for cloudy conditions and shadows from neighboring buildings. The sensor detects levels of daylight and overrides the Hyperion default, ensuring that shades only close when conditions are appropriate.

LOC C Series Occupancy sensor

Fig4.12 Occupancy Sensor

The ultrasonic sensors (US) have excellent minor motion detection and the passive infrared (PIR) sensors are better suited for major motion. The dual-technology versions combine both features to provide optimal energy savings and occupancy detection.

The LOS ceiling mount sensors all have self-adaptive technology that eliminates the need for manual adjustments. After correct mounting, the sensors automatically adjust sensitivity and timing to prevent false-off and false-on conditions. Model with an additional dry contact closure are available. These models can control other building systems such as HVAC or security systems. Self-adaptive sensors automatically adjust sensitivity and timing Passive infrared (PIR), ultrasonic (US) or dual technology (DT) Range from 450–2,000 ft² (mounted on an 8–12 ft ceiling) 8-second test mode to easily confirm proper operation Model with additional output (dry contact closure) available Non-volatile memory (saved changes are stored during loss of power) 20-24 VDC, class 2 (PELV) low-voltage wiring.

Radio power saver Wireless Daylight Sensor

Fig4.13 Daylight Sensor

The battery-powered, ceiling mount sensor saves energy by dimming or turning off electric lighting when sufficient daylight is available. The sensor detects light in the space and then wirelessly transmits the appropriate commands to the compatible dimming and switching devices via Lutron Clear Connect™ Radio Frequency (RF) technology; those controls then adjust the lights to take advantage of daylight.

Radio Power saver wireless occupancy sensor

Fig4.14 radio Occupancy sensor

Go green with Radio Power Saver. Wasted lighting can account for a majority of a building's total energy usage. And with many building spaces remaining unoccupied between 40% and 70% of the day, lights left on are a real energy drain. Lutron wireless occupancy/vacancy sensors automate the switching and dimming of those lights, saving energy and money.

It's also convenient. You won't have to worry about turning lights on or off anymore. Lutron occupancy/vacancy sensors automatically do the job for you every time you enter or exit a restroom, classroom, conference room, and hallway - even your own office. Going wireless eliminates the need for costly new wiring. Radio Power Saver sensors by Lutron install in as little as 15 minutes and communicate with compatible Lutron dimmers, switches and light control systems using reliable Clear Connect™ RF Technology, which ensures smooth, consistent performance

Occupancy Sensing Switch

Fig4.15 Occupancy Switch

A Lutron Maestro Occupancy Sensing Switch adds convenience and energy savings to any room in your home by automatically turning lights on and off. These sensors feature innovative, proprietary sensing technology to ensure lights stay on when the room is occupied. They also feature ambient light detection that senses light in the room and only turns lights on when needed. The sensor has a sleek design that blends in with your current décor.

Keypad

Fig4.16 KeyPad

Keypad is similar to switch board which we normal use in our home but it is more sophisticated than normal switch.

Normal switch have only ON and OFF option but a single button on keypad can be programmed differently. A single button can control Light, shade and Fan and even more devices. There is engraving option also by which you can engrave desired text on the button. A button on keypad can operate in different mode.

c. Define Load

In this step we select the load type for our area such as for our room we can select incandescent light, halogen, CFl, fluorescent or Eco system. We have additional feature so that you can select the watt of the fixture or load.

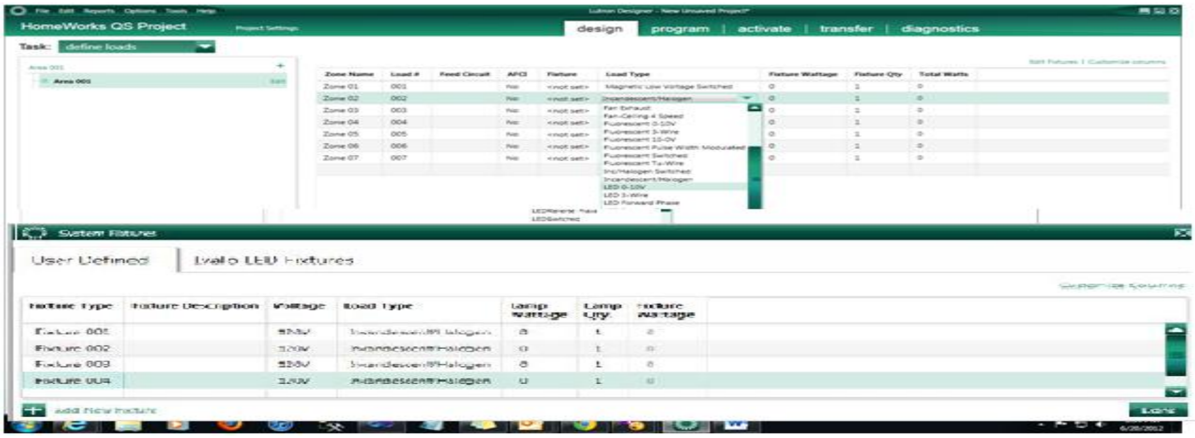


Fig4.17 Define Load and Fixture

d. Define Shade

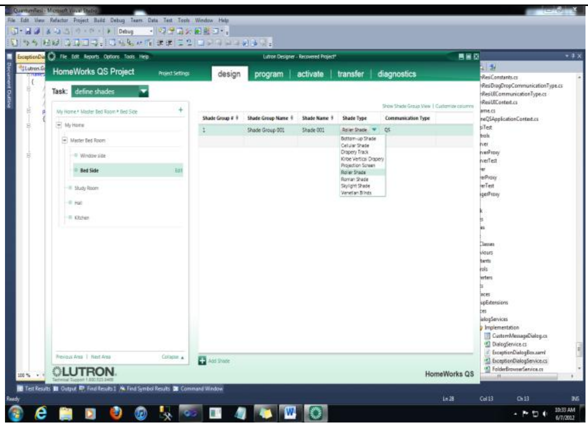
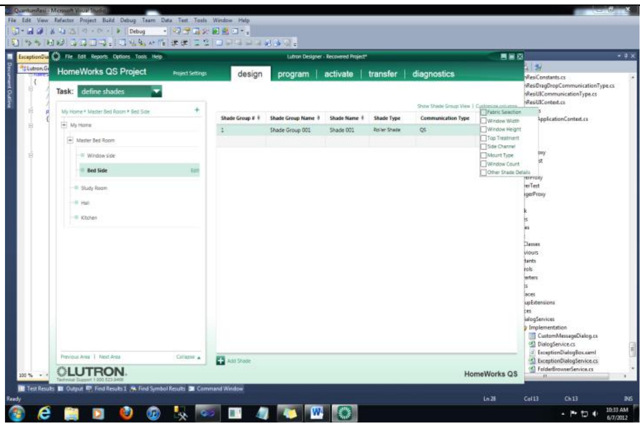
	

Fig 4.18 Shade with Diff Type	Fig 4.19 Shade with Diff Fabric

f. Define Equipment

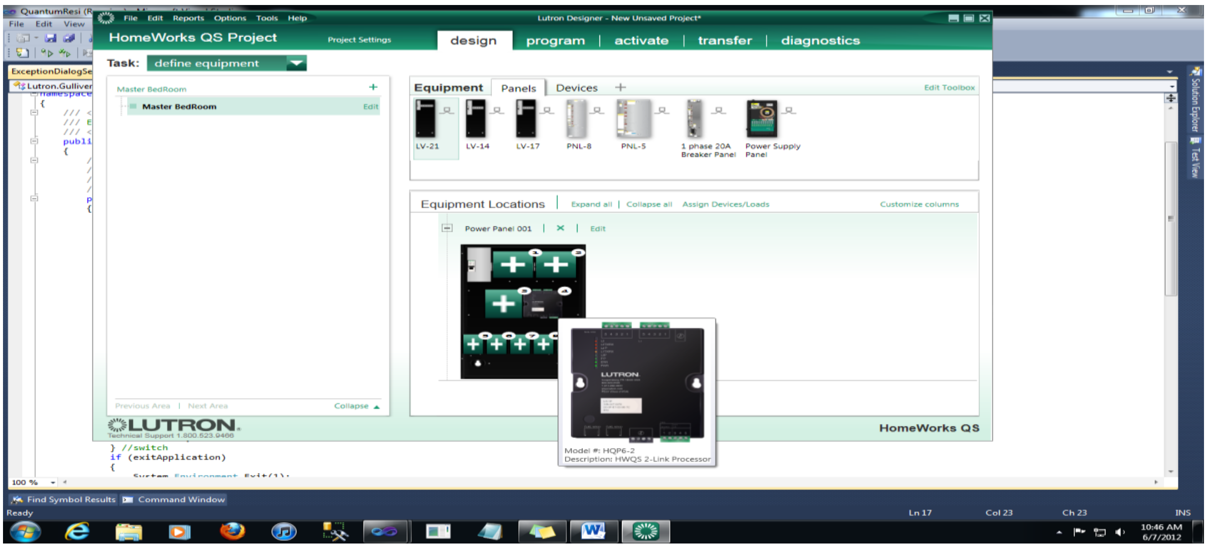


Fig 4.20 Controls of Area

g. Link Assignment

Step 3: Programming

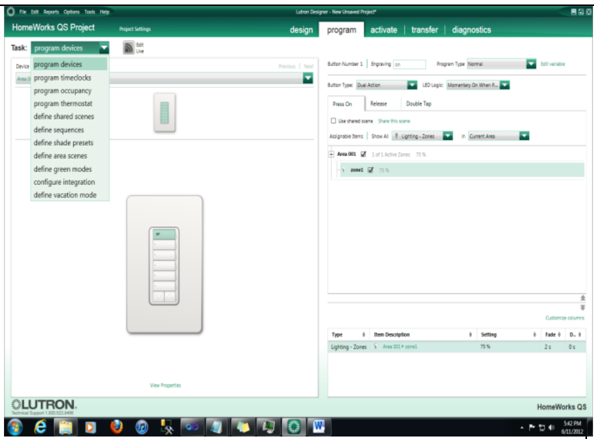


Fig 4.21 Program Device

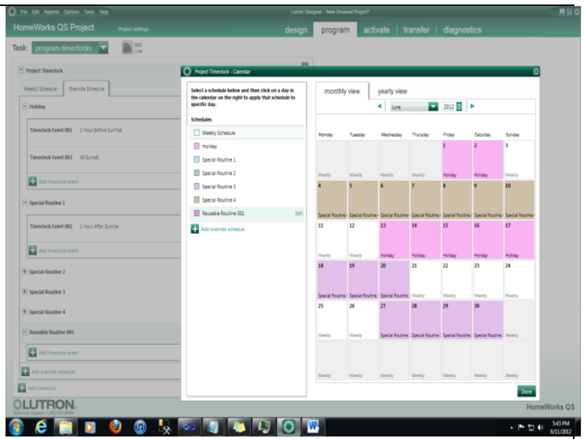


Fig 4.22 Time Clock

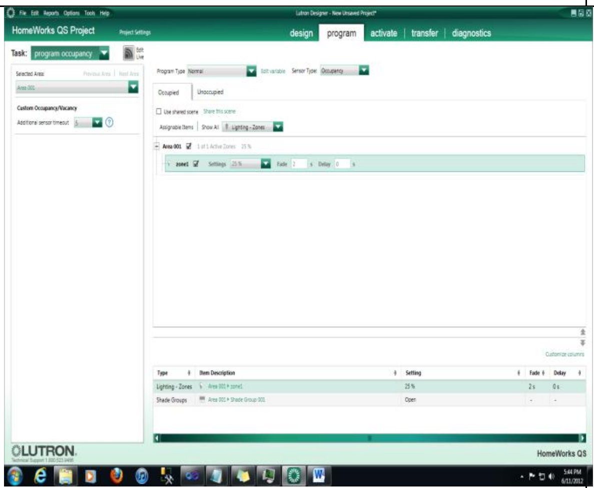


Fig 4.23 Program Occupancy

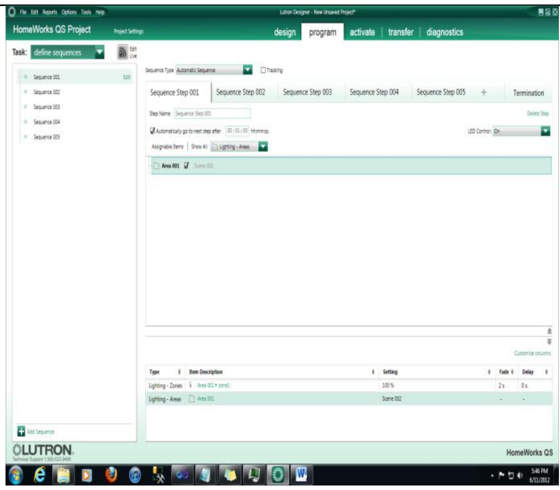


Fig 4.24 Program Sequence

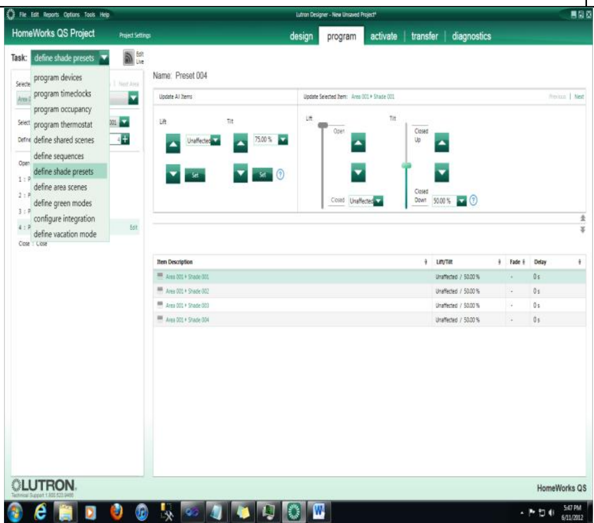


Fig4.25 Program shade Preset

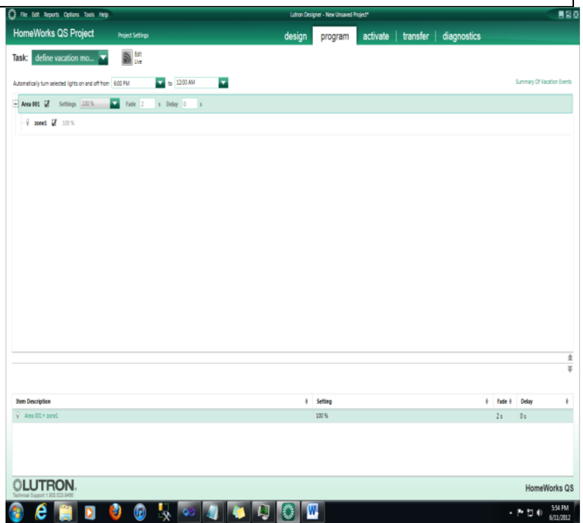


Fig 4.26 program Vacation mode

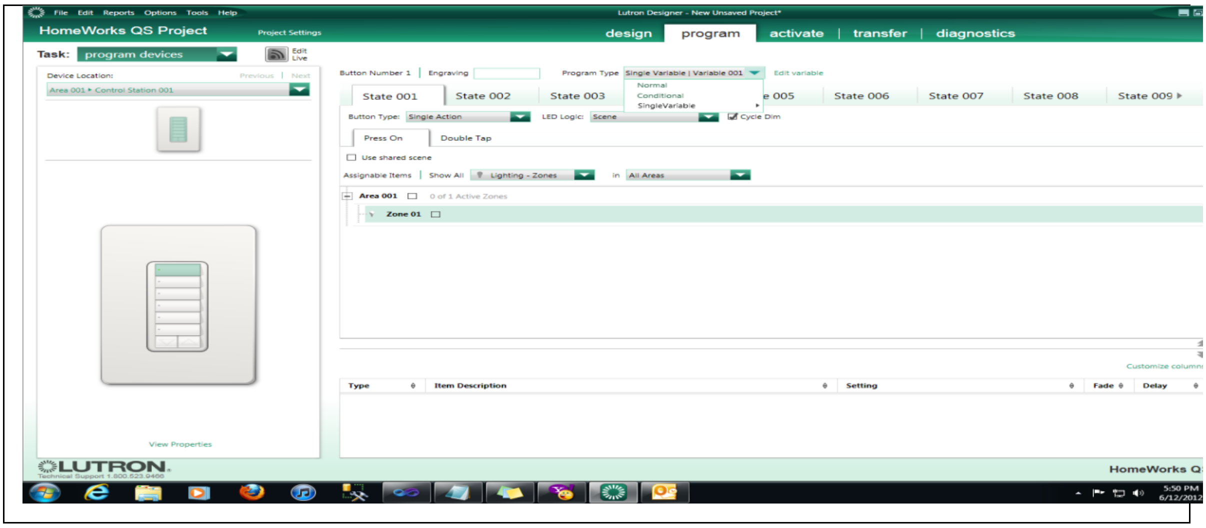


Fig 4.27 Device Variable Programming

Step 4 Activate

In this step we first activate Processor and then one by one other device. There are two mechanisms to activate devices either by providing product key of device to processor or Press activate button on the device and then power on the device start blinking and processor detect that device. After detecting the device press activate button on the screen.

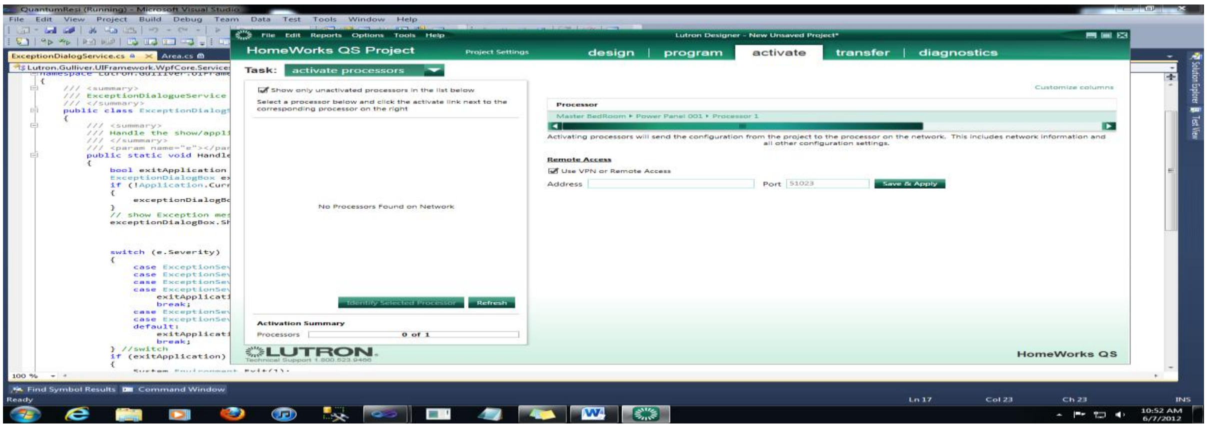


Fig 4.28 Activate Devices

Step 4 Transfer

In this step we transfer all program to processor in the form of flat file. Before the transfer of program file we match the OS of the processor and System OS. If OS version does not match then first update/degrade the OS version of the Processor. Once we transferred the file to processor then All Control of light well be handled by Processor. Processor transfer some files to the Devices which are the particular device specific.

Step 4 Diagnostics

In this step status of the devices are updated after some interval. In this step we monitor the Status of the Load and devices. In case any device goes out of order then status of that device is being display on the screen. This is a good tab which helps us to monitor our whole building by sitting at one place. Its save much time otherwise it will take too much time and effort to find which load is not working.

4.3 Wire Diagram [1]

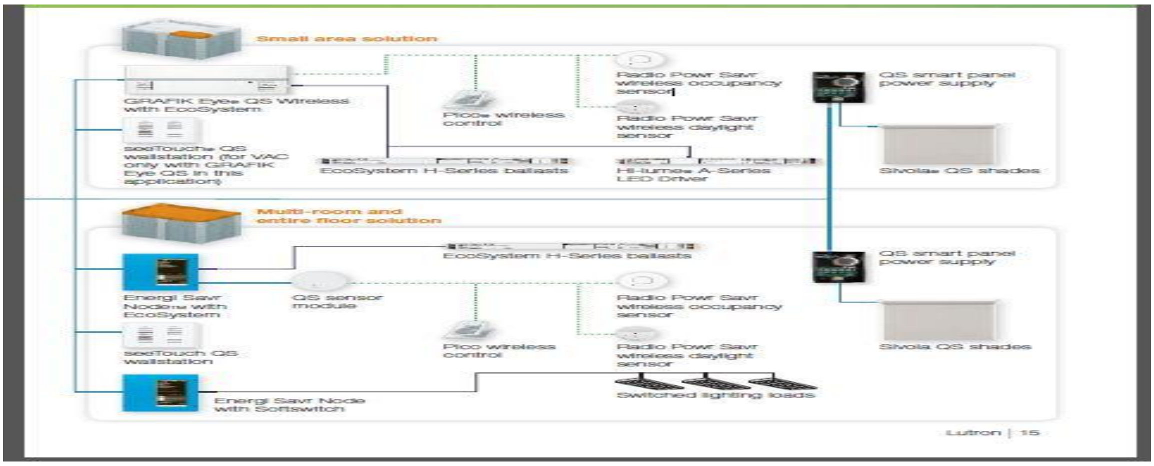


Fig 4.29 wire Diagram

CHAPTER 5

RESULT AND EVALUATION

Based upon the literature survey and different tools available such as - energy saving calculator and Green glance. WPF(Window Presentation Foundation) was used for GUI and to Program Electronic devices of Lutron. Following figures provide a snap sort of the energy saving and money saving in different scenario. The analysis also highlights the reduction in CO_2 Emission.

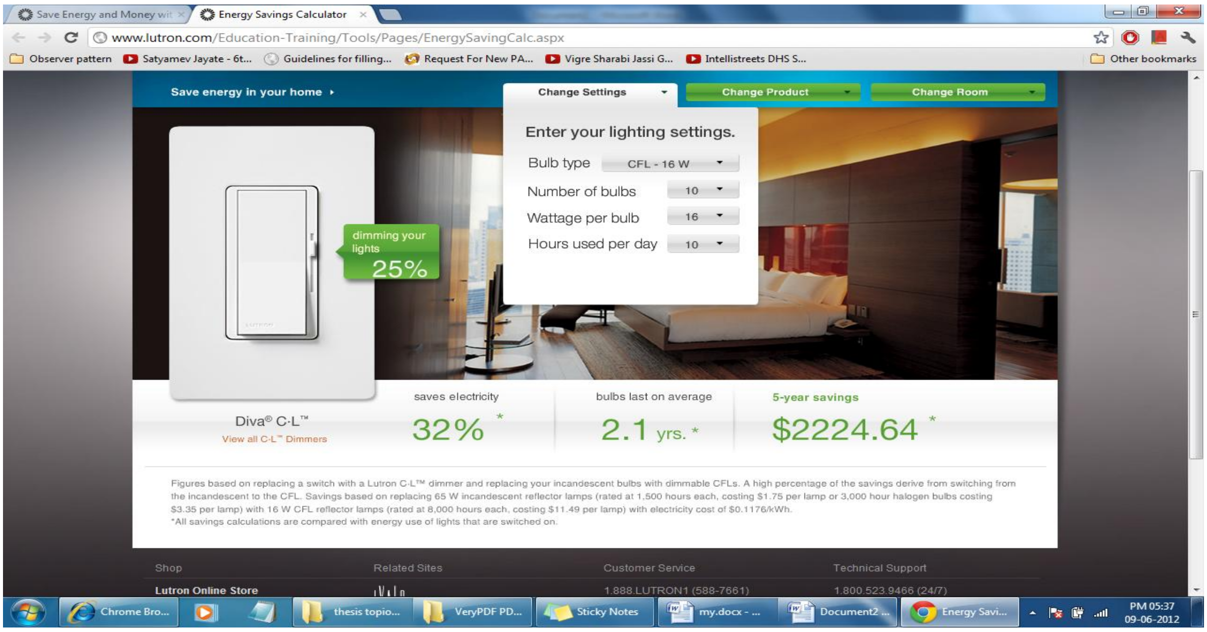


Figure 5.1 Calculated energy and saved money by CFL

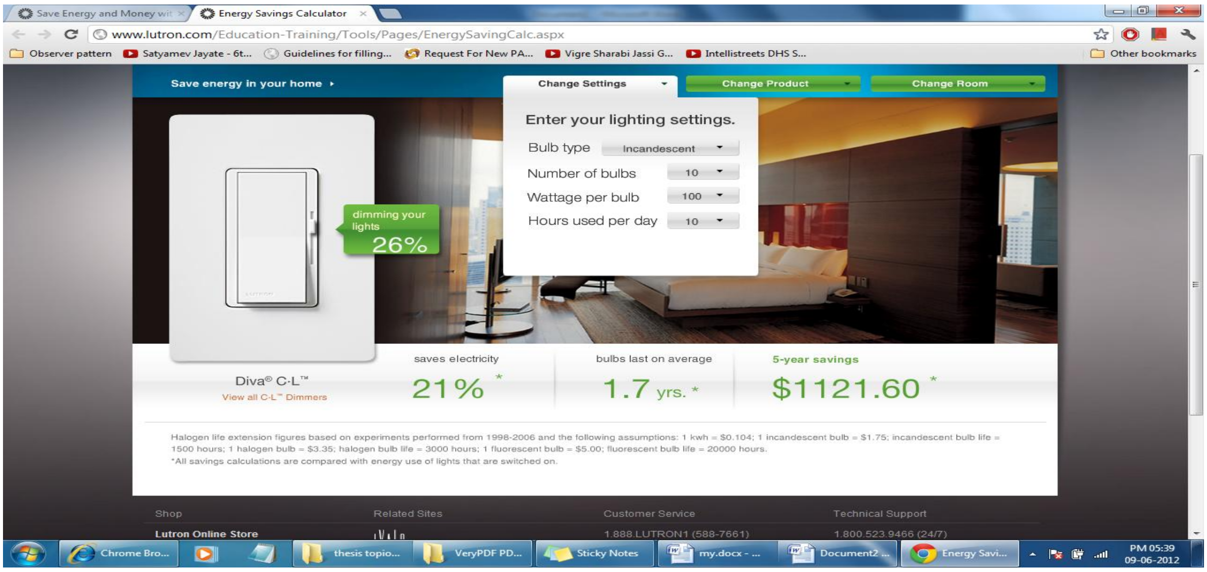


Figure 5.2 Calculated energy and saved money by Incandescent Light

Fig 5.3 Green Glance LCD Screen

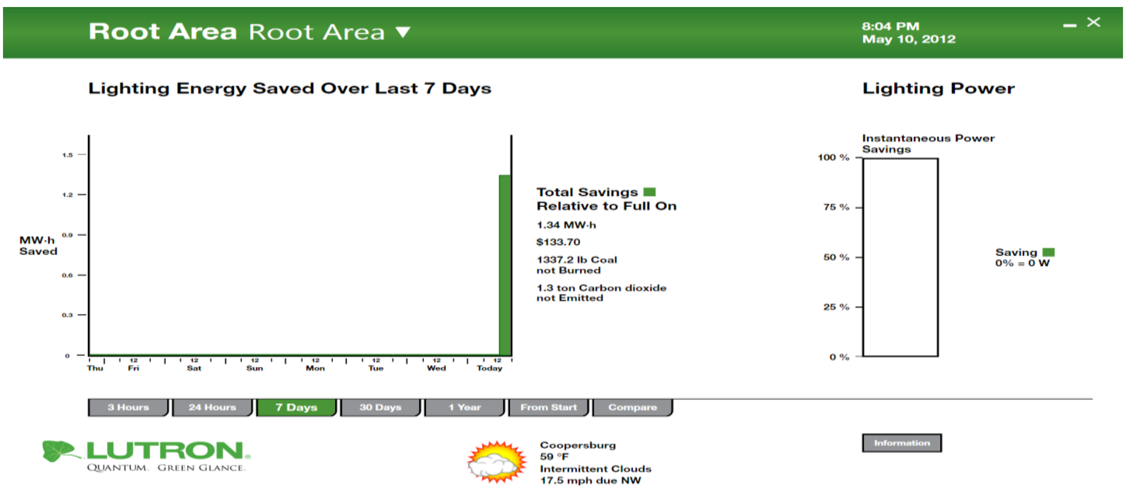


Fig 5.4 Energy Saving summary for 7 days

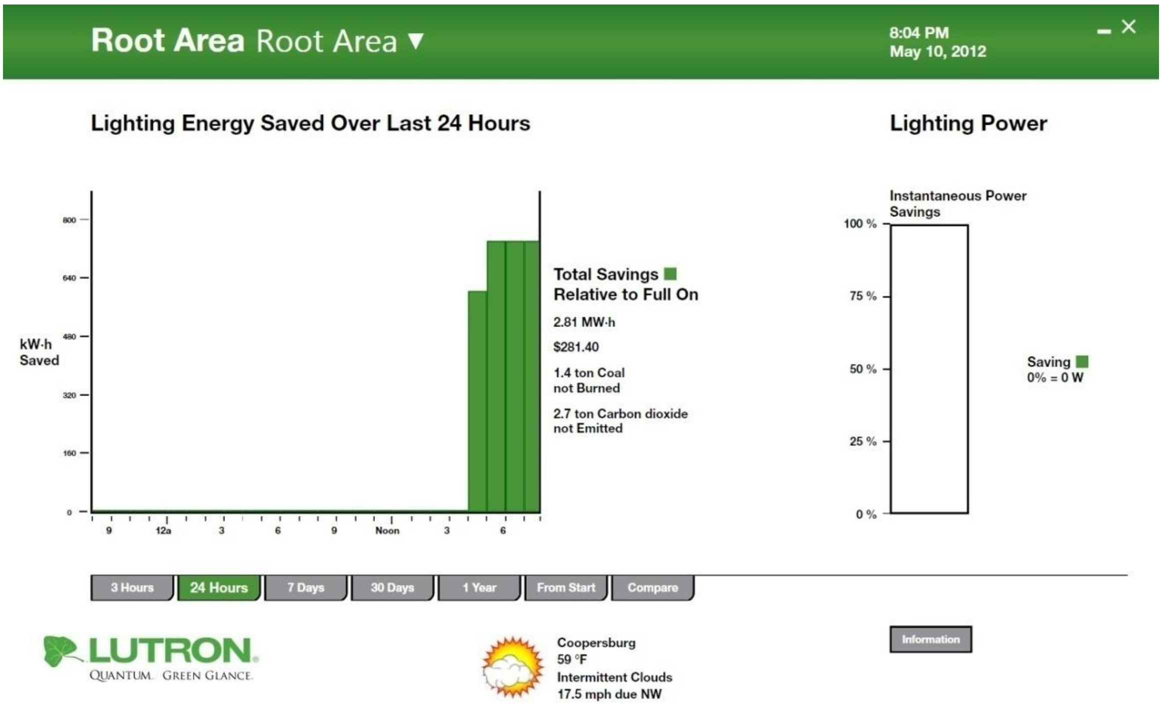


Fig 5.5 Energy Saving summary for 24 Hrs

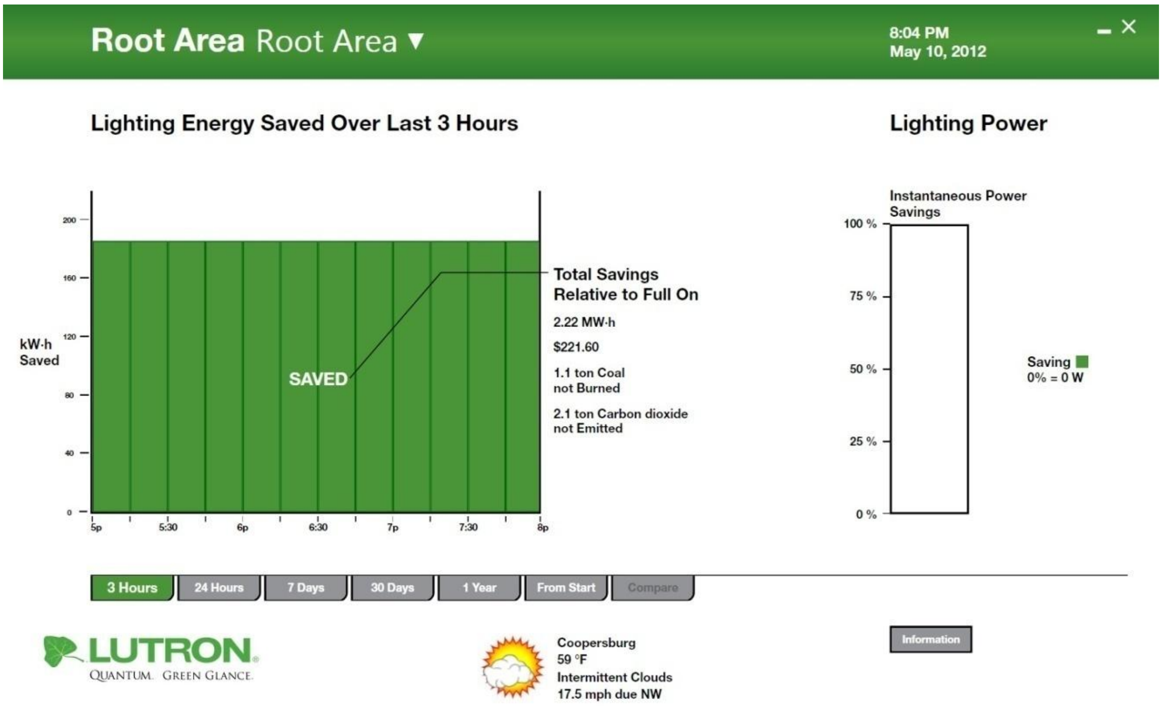


Fig 5.6 Energy Saving summary for 3 Hrs

CHAPTER 6
CONCLUSION AND FUTURE SCOPE

Faced with the skyrocketing cost of energy and environmental concerns, builders, architects and lighting specialists are increasingly turning to day lighting as a primary source of illumination in mainstream construction. Day lighting will provide tremendous operating cost reductions if properly integrated with an electrical lighting control system. For successful daylight integration, certain principles need to be followed in terms of optimum building placement: the location, design and selection of materials for fenestration (windows, skylights, etc.) and electrical lighting design. In general, the earlier in the design process of new buildings that day lighting issues are addressed, the more successful the daylight harvesting project will be. The designer should evaluate if the quality, distribution or amount of day lighting could be improved during pre-design and schematic design phases. Simulation software like Q-Design can be used to evaluate the full integration of daylight harvesting and electric lighting controls with buildings characteristics.

In summary,

1) An in-depth analysis has to be performed on the daylight harvesting potential of a building at the earliest possible stage before construction.

2) Total building automated lighting controls should be used to maximize daylight harvesting benefits and energy savings.

3) Energy efficient lighting equipment such as LED fixtures can be used to help cut lighting operational costs.

With the proposed solution we can manage both electric light and daylight, to not only save energy and simplify operations but also improve the comfort and productivity of the people in your building.

The term energy efficiency can be rephrased as follows,

– Only use energy when it is really required

– Only use the amount of energy actually required

– Apply the energy that is used with the highest possible efficiency

Further, following points should be taken care while saving Energy

1. Energy is saved with intelligent building control in comparison to Conventional Technology.
2. The level of potential savings depends to a high degree on the building parameters and the usage profiles.
3. The maximum energy saving potential is achieved using a combination of different automation functions.
4. The savings are fundamentally in the double-figure % range.
5. The required investment in intelligent building control is generally low in comparison to structural modifications to buildings.
6. The amortization periods are relatively short and are generally within one to five Years.

In future, we look forward to develop certain solar power fixture which can further help us in managing the energy and this work can also be extended on management of any other natural resources such as water. This resource can also be programmed by any resource provider (such as Municipal Corporation) so that the undue wastage of resource can be prevented.

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